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EDITORIAL.

ITEMS AND NOVELTIES.

An old Example of a "new" Boiler.—We present herewith a "cut" and description of one of the forms of steam boilers—the tubulous—upon which so many changes are at present being rung, and to which the name of "new" is given. If not the first, it is certainly an early record of the tubular grate-bar and of the tubular fire-wall combined with perfect water circulation. This apparatus was used for heating water.

The tubes B B are secured to and connect the side-box spaces C C together. A pipe E conducts the water to the bottom of one box, and a pipe D from the top of the other box, through a system of heating pipes returning to the pipe E again.

Fire is placed in the space A through the fire-door J: H is the

ash-pit and F the flue for escape of gases.—*Marquis de Chabannes, London*, 1818. J. H. C.

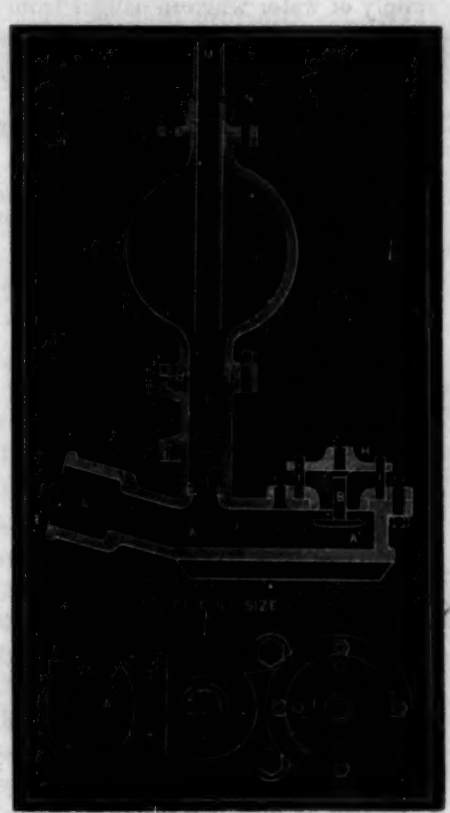
The Equilibrium Disk for lightning rods, is the name by which an invention of Prof. Burleigh's is known, and is designed, according to the inventor, to increase many times the inductive power of the lightning rod. The accompanying engraving gives a view of the new attachment which formed the subject of a very commendatory report from the Institute Committee on Science and Arts, at one of its recent meetings.

The usual size of the disk is two feet in diameter. Its weight, including the seventy-two horizontal and perpendicular discharging points, is about 40 pounds. It is made of one of the common metals, though copper is preferred. Iron, however, being cheapest, is generally used. Regarding the mode of using it, it is stated that it should be sunk into the ground deep enough to be surrounded by perpetual moisture, rarely less than six feet. By exact adjustment, the rod passes through its centre, and is firmly solidified to the disk by copper surrounding.

A new Niagara Bridge at Buffalo.—The Acts of Congress and of the Dominion Parliament have authorized the construction of a new Bridge across the Niagara at Buffalo. The Act authorizing its construction makes it a post route. The work will be under the superintendence of the directors of the Grand Trunk Railroad.

The Delaware Bridge.—The obstacles which have stood in the path of this important enterprise have at last disappeared, and there is every prospect that before the year has expired the work upon it will be energetically in progress. The original plan of a draw, which met with some objections on the part of the Examining Board, has been finally abandoned, and the plan of an elevated bridge, offered by Thomas S. Speakman, chief engineer, has met with approval.

An Hydraulic Ram.—Water enters the ram at A, and flows along the horizontal part A′ A′, escaping through the valve opening B. The valve plate H, secured to the valve stem, is guided vertically by 4 pins I. The valve C′ opens upwards into the vertical pipe F, which communicates directly with the base of the air-vessel D, and may be removed and replaced through the hand hole C; it is checked in its upward opening movement by a projection J on the cover C. A pipe E conducts the water from the base of the air-vessel to the exit pipe M, whence it is conveyed by pipes to the place where it is wanted.



The case A, cover C and air-vessel D are of cast iron; the valve B, plate H, and its seat, the valve C and its seat, and the coupling N and nozzle M are of brass. The pipe E is of wrought iron. The engraving is to scale $\frac{1}{12}$ size. J. H. C.

"Of the many and various situations where these rams are in use, I will only mention that the railway projectors, Messrs. Brassby, Baxton & Co., have in this way furnished different stations on the Tadela and Bilboa Railroad, in Spain, with water, and have thus saved the annual recurring expense of coals, workmen, and repairs of engines and pumps.

"In relation to the question of cost it may be remarked that the expense is, when compared to the manifold advantages it affords, in no respect proportional. Indeed, under the given conditions, the principle of the hydraulic ram is the most practical, the cheapest

and most efficient for elevating water that can be devised. It also affords the assurance to the improvers of property of an abundant supply of water when in danger from fire, as well as for the convenience and beautifying of the house and garden—so essential in our day to the comfort of an agreeable homestead.

Tabular Statement of the Different Sizes of Rams.

	Diameter of Supply Pipe.	Diameter of Main Exit Pipe.	Average Duty in Twenty-four Hours.
No. 1	1½ inches.	¾ inches.	300 to 500 gallons.
2	2 "	1 "	800 " 1200 "
3	2½ "	1½ "	1500 " 2500 "
4	3 "	2 "	3000 " 4000 "
5	4 "	2 "	4000 " 6000 "

"It must be remarked that for every gallon of duty afforded by rams, from 8 to 10 gallons of fall water are necessary."—*C. F. Jessen, in "Der Practische Maschinen Constructeur."*

The Detroit Tunnel.—From various sources we learn that the project of constructing a tunnel beneath the Detroit river seems now to be in a fair way to be realized. If completed, it will be the most extensive engineering work of its kind in this country, or, probably, elsewhere. Upon the plan at last approved by the Company, the length of the work between the extreme portals is to be 8568 feet. It is to be built in two separate parts, which are to be cylindrical in form and fifty feet apart: the design being to avoid in this way any interruption to the passage of trains—it being presumable that an accident would be confined to but one of the compartments.

A Pneumatic Sounding Apparatus, acting in a manner analogous to a barometer, was recently described before the Institution of Naval Architects, by Mr. W. C. Bergius. The principle on which it operates is that it indicates and registers the maximum hydrostatic pressure to which it has been subjected, and is therefore independent of the movement of the ship, or of the amount of slackline overboard.

A new Ice Machine.—The plan of M. Mignot, a French inventor, by which it is proposed to utilize the cold produced by the

dilation of compressed air, for the artificial production of ice, has recently found application in practice. A machine upon this principle has been built in Manchester, England, for a London manufacturer, but as yet nothing relating to its performance or efficiency as compared to the other well known ice-makers, has been made public.

Coating Brass with Copper.—Dr. Puscher* dissolves for this purpose 10 parts, by weight, of sulphate of copper and 5 of sal ammoniac in 150 parts of water. The brass, well cleaned and free from grease, is dipped and left for a minute in this mixture; it is then removed, allowed to drain for a moment, and heated over a charcoal fire until ammoniacal fumes cease to be given off—when the film of copper is perfect. It is simply washed with water. The copper coating is said to cling firmly.

Earthquake Statistics for 1870.—Prof. C. W. C. Fuchs, in his yearly report, records for the year 1870, one hundred and thirty-one earthquakes. Mexico, Japan, Greece and Italy seem to have suffered considerably from these unpleasant visitations. In the latter country alone, from this cause, 99 persons were killed, 222 were wounded, and 2225 houses were destroyed. But one phenomenon of this kind is accorded to the United States, and this is one, too, of a mild character. It occurred on the 20th of October, was most perceptible in the Eastern States, lasting but 20 seconds, and confined its performances to dislocating a few houses.

The Heliotype Process.—The art of reproducing photographic images rapidly and cheaply by a mechanical printing process is being steadily developed; and we may at no distant day expect to see it brought to such practical perfection as to take the place, in a great measure of the lithographic process now in almost universal use.

It was discovered some years ago, that a film of gelatin saturated with bichromate of potash acquired, on exposure to light, certain properties, which have since that time to the present taxed the ingenuity of numerous observers to utilize. The most important of these properties is, that in those parts where the light has acted upon such a film, it will take up greasy ink, precisely like a lithographic stone, while the parts unaffected by light will absorb water. A number of photo-lithographic processes depending upon this property for their efficiency have been from time to time announced;

* Bay. Ind. u. Gewerbe Blatt, *Feb.*, 1871.

but few, if any, appear to possess all the qualifications requisite for extended adoption in practice.

The Albertype process, discovered by Albert of Munich, is one of the latest and best. In this, a plate of moderate thickness is coated with a thick film of liquid bichromated gelatin, which is subsequently exposed to the light to render it insoluble. This is then coated with a thin coating of sensitive gelatin, which is exposed to the light beneath the negative which it is desired to reproduce; from this film thus obtained, which is rendered indifferent to further change by washing, most excellent prints are obtained by the lithographic process.

The Heliotype process,* the latest development of the art, differs from the one just described, in a number of details, by which greater toughness, durability and freedom of manipulating films is secured. Mr. E. Edwards, the discoverer of the process, adds alum to his bichromated-gelatin solution, and finds that by this addition, while the sensitiveness and subsequent ink-absorbing property of the films are not the least impaired, they possess, to a far greater degree than has yet been obtained, the property of swelling but very slightly in water, and the power of resisting the action of the printing press.

The gelatin films are spread on finely ground glass plates, which are so prepared by polishing with wax as to admit of their subsequent removal. The films, carefully dried, are exposed beneath the negative. The impressed films are then washed in the dark room and caught on zinc plates. To these the films are firmly attached by pressure, by which at the same time all remaining traces of free bi-chromate are removed. The films thus prepared are ready to undergo the printing process. By varying the consistency of the ink, it is possible to print in two colors; the stiff ink affecting only the portions most changed by the light, while the thin will take hold of the half tones. After use the films are removed from the zinc plates and preserved for future printing.

On the transmission of the Sound of the Human Voice by rods of English Deal. By Prof. Edwin J. Houston.—An interesting modification of Wheatstone's celebrated experiment of the Telephonic Concert was recently tried at the Central High School of Philadelphia. A rod of English Deal, about twenty feet in length and three-quarters of an inch thick was let down through a

* For detailed accounts of the history and successive stages of this process, see *Journal of Photography* and *Nature*, Vol. IV, p. 85.

platform into the room below. Insulation from the platform and the ceiling of the lower room was obtained by enclosing the rod with small sections of thick rubber hose, against the lower end of the rod the sounding box of a small tuning fork was placed. On speaking or singing into the open end of this, the sounds were transmitted by the rod to the room above, the volume of the sound being increased by placing a guitar on the upper end of the rod.

The experiment is exceedingly interesting and striking. Although the interval between the notes is perfectly preserved, their intensity and quality are changed very decidedly, the effect being similar to that produced by ventriloquism. As the position of the rod is immaterial, striking effects can be produced as though by ventriloquism. A small figure placed on the end of the rod or on the sounding box adds greatly to the effect. A song is transmitted in a very amusing manner. As it is preferable to have the sounding box held so that the pulses should impinge in the direction of the length of the rod, the experimenter in the room beneath rested for convenience, on a settee. This mode of transmission of sound does not, of course, give as good results as by means of hollow tubes, as the transmitted sound cannot be heard at as great a distance. It is, interesting, however, from its novelty.

New Spectroscopic Combination.* By P. A. Secchi (in a letter to Prof. Silliman, dated Rome, April 19, 1871).—I have the honor to announce to you the discovery of a new spectroscopic combination, by the aid of which one can see the images of the spots and of the solar protuberances, with the spectral lines all at once in the same field.

This result is reached by two methods: 1st, by placing before the objective of the telescope a prism as large as that which I employ for star spectra, say of six inches opening, and causing the colored image which is produced at the focus of the lens to fall upon the slit of the ordinary spectroscope.

2d. The other method, less costly, consists in placing a direct-vision prism of a high dispersive power in the path of the luminous rays before they arrive at the focus, and over the slit of the common spectroscope.

By these two methods is obtained in the field of the spectroscope, the solar image formed of different colored shades, with their spectral lines, but very sharply defined with their spots and margins

* *Am. Jour. of Science*, June, 1871.

quite exact, so that the details of the spots can be examined as with a colored glass.

If the sun's limb falls near the line C, which as we have just said, is seen at the same time as the image of the sun's limb, we see the chromosphere and the prominences showing themselves as brilliant lines more or less elongated from the sun's limb, according to the height of the prominences. The narrower the slit the sharper the image of the spots.

Thus the protuberances are seen as brilliant lines, but their form is recognized only by linear sections as in the old method of Janssen. Nevertheless their height can be perfectly recognized and measured by measuring the distance from where the line C becomes brilliant to that point on the sun's limb, which is upon the same normal to the limb. By opening the slit the form of the protuberances can also be recognized, but only with a loss of precision of definition. By a narrow slit the height and position of the protuberances can be recognized and measured with the greatest precision, and their position fixed with reference to the spots and faculæ, in a manner far more simple and certain than with the ordinary spectroscope.

If in a spot there is a jet of hydrogen, C is at once seen to become more brilliant, or at least the darkness is diminished, and the lines of calcium and of iron become broader, &c., as in ordinary observations, but with far greater satisfaction and certainty of position.

I have observed the spectrum of the little comet of Winnecke, and I have found a band in the green similar to that in the other comets.

The Physical Constitution of the Sun.—A recent paper by Prof. Norton* contains an elaborate discussion of the subject heading this notice. Perhaps the most interesting portion is that which relates to the origin of the sun's flames or protuberances, and the corona, to which the attention of astronomers and physicists, has of late been so closely directed. In connection with this subject, Prof. N. announces as highly probable the declaration of Faye, that the slow process of cooling going on at the solar surface has the effect of reducing the temperature to such an extent that certain vapors having a strong affinity for oxygen will enter into union with this element. The compound molecules thus formed will possess a greater weight in comparison with the repulsion to which they are

* *Am. Jour. of Science*, June, 1871.

exposed, and will therefore descend more or less rapidly into the photosphere. No further visible effect would be produced were this the whole process; but it is highly probable that the descending masses would arrive at a depth where the higher temperature would effect a dissociation of the combined elements.

This sudden dissociation of combined elements, though occurring at considerable depths within the photosphere might, according to the author, play an important role at the solar surface. He considers it probable that under certain circumstances these dissociated elements would be urged upward by repulsion, and pass with greater or less velocity through the several envelopes. Hydrogen should, accordingly, rise to the greatest heights, and should make its appearance in sudden outbursts above the chromosphere. In support of his proposition, the author adduces the announcement of Lockyer, who detected in the solar protuberances a velocity of 120 miles per second, and a height of 40,000 miles, and of Prof. Respighi, who has even detected in such a prominence an elevation of 160,000 miles above the sun's photosphere.

The idea is likewise advanced that the corona, which has been traced, with the aid of the spectroscope, by various observers, as far as 425,000 miles from the sun's limb, may be due to a substance several times lighter than hydrogen, in which solar repulsion might predominate over the attraction of gravitation, urging the subtle fluid from the sun in all directions.

A Nitro-Glycerine Explosion.—Dr. E. F. v. Gorup-Besanez mentions in a late exchange* an account of the explosion of 10 drops of nitro-glycerine, which took place in his laboratory, and which, from the astonishing effects produced, is well calculated to give one a most respectful notion of its explosive properties. One of the Doctor's pupils, in the course of an investigation, placed the quantity of nitro-glycerine mentioned in a small cast-iron saucepan, which was heated over a small Bunsen-burner.

The effect was, that forty-six panes of glass in the laboratory were broken to pieces, the iron pan was hurled through a brick wall, the stout iron stand on which the vessel had been placed was partly split and partly twisted out of shape, and the tube of the Bunsen-burner was split and flattened. Fortunately, none of the persons in the laboratory at the time were injured. The author in this connection, calls to the attention of his readers a communi-

* *Chemical News.* Notes from foreign sources.

cation of Dr. E. Kopp on the conditions under which this substance explodes or quietly burns. When caused to fall, drop by drop, on a full red-hot iron plate, it burns off like gunpowder; but should the iron plate not be thoroughly red, yet hot enough to cause the nitro-glycerine to boil suddenly, an explosion invariably occurs.

Separation of Combined and Graphitic Carbon.—Boussingault* describes a new method of accomplishing the separation of the combined and graphitic carbon in iron analyses, which, from its simplicity, is worthy of mention. Though the absolute separation and determination of these two important constituents of iron is not possible by any analytical process yet devised, the one about to be mentioned affords the analyst an easy method of determining the relative quantities of readily oxidizable and difficultly oxidizable carbon contained in a sample, which is a matter of great importance to the practical chemist.

Boussingault treats his irons with bi-chloride of mercury, and heats the residue thus obtained in the air to a temperature not exceeding dull redness. The combined carbon is by this means totally consumed, and may be determined by the loss in weight; while the graphite remains behind unchanged. The quantity of this latter is to be estimated by combustion in a stream of oxygen, in the usual manner.

Though no mention is made of the fact, we may infer that the treatment with mercuric chloride is for the purpose of converting the iron, with its accompanying metallic constituents, into soluble chlorides; that these are then extracted by digestion with distilled water, and that the residue then remaining, which would consist of silica and the two kinds of carbon, is the residue referred to, which is to be heated in the air, &c. In the original paper, the caution is added to heat the residue, after each combustion, in an atmosphere of hydrogen, to reduce to its normal condition any traces of iron which might accidentally have been mechanically retained in it.

Reduction of Chloride of Silver.—Dr. Graeger, in a communication to *Dingler's Journal*, states that the use of metallic zinc, for the reduction of chloride of silver, is greatly to be recommended; inasmuch as it affords a silver much purer than that obtained by the wet process of reduction now in use.

Combustion under Water.—An experiment which we believe will be new to some of our readers (and perhaps interesting) is a

* *Ann. de Chim. et de phys.*, *XX*, 243.

simple and brilliant method of showing to an audience the phenomenon of combustion under water. The ordinary mode of leading a jet of oxygen upon phosphorous melted under water is attended with a few inconveniences, the chief of which, if we except the disagreeable necessity of handling this unreliable substance, are the short duration of the phenomenon and the great liability of the breakage of flask, from the intense heat produced at the point of combustion. The experiment to be described is free from all these inconveniences, and is, from the experience we have had with it, entirely superior to the one mentioned above. If the ingredients for the well known Red Fire are taken, and the strontium and potassium salt, but especially the former, before the mixture is made, are thoroughly dried upon the sand-bath, the mixture will be found to burn under water, if first ignited before being plunged into it, with quite a brilliant effect, throwing a glow of light in all directions. The best form to be recommended is to make a cone or cylinder of glazed or silvered paper, to fill this tolerably tight with the well-dried mixture, and close the base so as to be impervious to water. To be used it may be attached to the end of a wire, ignited at the point and plunged into a large jar of water, where it will burn with much energy until exhausted.

Necrology.—By recent advices from England we learn of the death of one of the most talented of young British mechanical engineers. Mr. Ferdinand Kohn has a reputation among engineers as author of a well known work on "Iron and Steel Manufacture," and as an able contributor to our valued contemporary *Engineering*.

He was a Bohemian by birth, and was educated in the Austrian technical schools. After some practice in Austria, he removed to London, where he has since remained.

He has taken an active part in the introduction of Bessemer's, Siemens', and other valuable processes, and was appointed by Austria to report upon the Paris Exposition.

We had the pleasure of meeting him in London a few months since, and his learning and his practical knowledge of all European processes of iron manufacture made him an invaluable, while he was also an exceedingly pleasant acquaintance. He was an enthusiastic admirer of American institutions—except, of course, our tariff—and was hoping that an intermission in his pressing business engagements might enable him to visit the United States and study our methods.

Mr. K., by careful preparation in the School of Technology and

by a wide and keen observation of actual practice, had combined to an unusually fortunate extent high scientific attainments with great practical knowledge. He was an excellent representative of the advanced school of modern mechanical engineers. His personal character was admirable, and in his death his friends and the profession have experienced a very great loss. R. H. T.

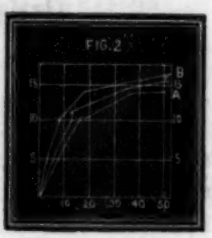
Arsenic in Aniline Dyeing.—The dust of some print works, in which aniline colors were printed by acid of arsenate of soda and acetate of alumina, has been analyzed by Bolley, who found it to contain quite a perceptible quantity of arsenic. The method of testing was the ordinary one, with Marsh's apparatus.

The Lifting Power of Electro-Magnets has generally been assumed to be proportional or very nearly so to the power of the current employed. From some accurate experiments of Von Waltenhofen with apparatus shown in Fig. 1, it appears that this is true only within very narrow limits as will be seen from the tables where the same horse shoe electro-magnet is used with three different armatures, and where *s* is the measured power of current *p*, the corresponding degree of saturation produced in the unarmed magnet, as measured by its influence on a magnetic needle and L the lifting power measured in kilogrammes.

Armature A.			Armature B.			Armature C.		
S	*p*	L	S	*p*	L	S	*p*	L
16·29	3·01	1·97	16·3	3·10	5 37	15·87	3·31	3·75
28·11	5·77	4·17	37·40	7·15	8·97	27·34	5·57	6·15
35·29	6·79	4·92	45·55	8 74	10·27	37·33	8·12	7·35
45·55	8 91	6·27	91·05	17·60	13·87	59·95	12·86	9 90
89·35	17·78	10·27	286·28	49·75	16·24	62·85	13·52	10·90
96·86	18·98	10·27				101·02	21 95	12·82
130·01	24·85	11·87				163·09	35·44	14·50
188·77	38·29	14·02				213·95	46·20	15 50
246·53	51·89	14·42						
249·23	52·12	14·42						

The armature A is an electro-magnet precisely similar to the magnet experimented with, but with no current passing through it. B is the armature A charged by the same current as the expe-

rimental magnet. C is a piece of soft iron rounded semi-cylindrically on the side resting on the magnet. In the graphical representation, Fig. 2, made from these tables by taking the degrees of saturation as abscissas, and the lifting power as ordinates, the curve for the armature C runs between the magnetized and unmagnetized horse-shoe armatures; and all three show a pretty rapid convergence to an asymptote parallel to the axis of abscissas, representing a maximum of lifting power of about 18 kilogrammes. It will also be observed by examining the columns of p and L that the observed lifting powers approach this maximum at a strength of the electric current, which in the unarmed magnet only produces about half the saturation.



The influence of Violet Light in stimulating vegetable and animal growth. A pamphlet recently presented, by request, before the Philadelphia Society for promoting Agriculture, by Gen. A. J. Pleasanton, contains a detailed account of a series of experiments conducted during ten years, on the above subject, the results of which are quite surprising.

Impressed with the belief that the actinic qualities of the more refrangible rays—blue and violet—of the spectrum might be practically employed to stimulate the development of life, the author constructed, as early as March, 1861, a grapery in which every eighth row of glass was violet-colored. In this, cuttings of some twenty varieties of grapes, each one year old and of the thickness of a pipe-stem, were planted. We are informed that within a few weeks after planting, the walls and inside of the grapery, which was 84 feet long, 26 feet wide and 16 feet high at the ridge, were closely covered with the most luxurious and healthy wood and foliage. A number of vines of the same varieties and age, which had been planted in a grapery of ordinary construction, had some months later acquired but a trifling growth. In the fall of the next year the vines bore the immense yield of 1200 pounds of grapes, the bunches being of unusual magnitude. In 1863 the yield was two tons, and the yield has continued, without symptoms of decay or exhaustion of the vines, until the present time.

The success of the experiment with vegetable life induced the author to try the plan upon the development of animal life, and though the results obtained were by no means so surprising as in the former case, they were still quite marked. He informs us that he has succeeded in developing into full size, and with all the functions of maturity, in the space of fourteen months, a bull calf so puny and feeble at its birth that it was not expected to live.

The results here announced are surprising, though they afford an additional and beautiful confirmation of the announcement long since made upon the functions of the various portions of the solar spectrum.

Editorial Correspondence.

DR. WAHL:

My Dear Sir—Several months ago I stated to you that a mineral specimen had been sent me for analysis, which proved to be metallic antimony, and I enclosed, with the statement, a fragment of the substance sufficient to substantiate the fact. The sample sent me weighed about an ounce and a half, and I had hoped at that time, from the representations and promises made to me, to have been able soon to furnish you with a better specimen and with a fuller account of the discovery, location, probable amount of the mineral, and other facts relating to this very interesting substance. But, thus far, I have been unable to verify the statements made me, or to obtain the additional specimens freely promised at the time the above specimen was forwarded me for analysis, although it was represented that it was a portion of a mass weighing about twenty pounds.

I would regard the whole matter as a hoax, and an attempt at fraud, were it not that certain facts render its truth probable, and that the appearance of the mineral corresponds so decidedly with the distinctive features of native antimony. In view of the indefinite character of the information on all points, nothing more than a superficial examination was made, but I trust that, in a short time, duly substantiated statements will be obtained. It is certainly to be regretted that any uncertainty should attach to so interesting a mineralogical phenomenon. I have reason to believe that samples of the mineral were furnished to other parties about the same time, and you may receive confirmatory accounts from other sources.

CHARLES F. HIMES.

Dickinson College, June 10th, 1871.

NOTE.—The sample which was received from Prof. H. in his former letter was sufficient to give all the blowpipe tests for its recognition as metallic antimony. As the Professor remarks, it is to be hoped that the uncertainty concerning the origin of his specimen will soon be removed by more definite information. Should his suspicions be verified, the occurrence would be of a most interesting character.—ED.

Civil and Mechanical Engineering.

ON THE USE OF PULVERIZED FUEL.

By Lieut. C. E. Dutton, U. S. Ordnance Corps.

(Continued from Vol. LXI., page 385.)

The economy of high temperatures over low ones (provided they are obtained without enormous increase in the consumption of fuel, and provided also, they are not so great as to act destructively upon the materials subjected to them), is vastly greater than would at first seem, and out of all proportion to the increase. It is an unfortunate fact, that the temperatures at which the operations of heating and puddling are performed, approach near to the extreme temperature attainable in the flame from the grate. After the fire has been in operation a few hours, the temperature of the roof, walls and bath of metal, will be equal to that of the flame, less the temperature lost by conduction through the walls. At high temperatures this loss is known to be very great, and is proportional to the time occupied by the gases in passing from the fire-place to the throat. If the flame have the maximum temperature due to that mode of firing, then the only way in which it is possible to increase the temperature of the bath of metal is to increase the volume of gases passed through the furnace, and the consequent velocity with which they pass; we then diminish the time, diminish the proportional losses of heat and temperature—thus bringing the temperature of the bath nearer to that of the flame. But the proportional increase of temperature thus obtained is much below the proportional increase of fuel expended.* This is illustrated daily by unskilful, ignorant heaters, who send through the hearth immense volumes of flame and gas, under the impression, no doubt, that the

* Let q= the quantity of heat required to raise the temperature of the gases to 2500°. Say the temperature of the bath is 2200°, in which case 300° is lost by radiation, or $q \cdot 12$. We desire to raise the temperature to 2300°, in which case the loss would be $\cdot 08\, q'$. This can be effected only by making q' much larger than q. The proportion $q' : q :: .12 : \cdot 08$ would be insufficient, because the rate of loss at 2300° is greater than at 2200° by about $\cdot 06$; making the proportions $q' : q :: \cdot 12 \times 1 \cdot 06 : \cdot 08$, or $q' = q \frac{\cdot 12 \times 1 \cdot 06}{\cdot 08} = q \times 1 \cdot 59$. In other words, requiring 59 per cent. more heat. As the temperature of the gases is assumed to be the same in both cases, the increase must be in their volumes, which represents a corresponding increase in the quantity of fuel burning. [The temperatures selected are arbitrary, and for purposes of illustration only; still, the foregoing estimate approximates to the real facts of the case.]

effect produced is directly proportional to the quantity of fuel consumed, while, in reality, very little, and sometimes no increase of temperature is obtained. The efficiency of heat, or the rapidity with which its effects are communicated, are related in a complex ratio to the difference between the temperature of the radiant and that of the recipient. For a given difference it varies in an increasing ratio with the absolute temperature of the two elements.

Let us apply these considerations to the various stages of the puddling process. The first stage, where the iron is melted, may be materially shortened by the more intense heat of pulverized fuel. In the second, or boiling stage, time is required to perfect the chemical reactions, and its duration cannot be materially shortened by any amount of heat. Moreover, it is desirable to boil at the lowest temperature consistent with perfect fluidity. But the much greater temperature obtainable by the use of a given supply of coal, in the form of dust, enables us to reduce the rate of consumption very materially, and yet preserve a sufficient temperature. In the third, or balling stage, where the highest temperature is required, we may attain it by a much smaller increase of consumption than would be necessary by the grate-burning method. In the heating furnace, also, the advantages of increased temperature of the flame are equally conspicuous, since they materially shorten the time of an operation, and obviate the necessity of increasing enormously the consumption of fuel, in order to obtain the last increments of heat in the pile.

We may observe here the operation of a general law of thermal physics, that the rapidity of thermal action due to given differences of temperature; is greater at high temperatures than at low ones; and hence when we add to our command of it we increase in two ways: we increase the number of our units and augment largely the value of each unit. Hence we account, by means of simple physical laws and familiar facts, for the greatly increased effects of small additions to high temperatures. We are also prepared to consider entirely just and reasonable the claim put forwerd by Messrs. Whelpley and Storer, of a very large economy obtained by their process, in the expenditure of fuel in the operations of the reverberatory furnace. They state that in a practice extending over eight months, the use of a pulverizer attached to a double puddling furnace has given a general average consumption of 1250 pounds of coal to the ton of puddle bar. It is usual to estimate ordinary pud-

dling at a ton of coal to the ton of iron, in which case pulverized fuel would give an economy of forty-five per cent. of the amount at present used. Large as this claim may seem, every theoretical and practical consideration with which I am familiar, leads me to the belief that it is entirely rational and intrinsically probable.

But Messrs. Whelpley and Storer have not only demonstrated in their experimental furnace at Boston, that a much higher temperature is attainable by the use of pulverized fuel than by the grate-burning method, and this with less coal; but they have also obtained, at moderate cost, a temperature comparable to that obtained in the Siemens furnace. This will not appear at all surprising when we come to examine the facts of the case. The temperature of the Siemens furnace is not by any means so high as is usually supposed by those who have never investigated it. By whatsoever method this investigation be conducted, it will readily appear that this temperature cannot be more than 350° to 400° F. above that of the common reverberatory furnace used for heating, and is probably less even than that—say 2500° to 2550° F. This applies, of course, to the ordinary temperature of that furnace, when making steel, which may be melted at about 2500° F. That the temperature cannot be more than slightly above this melting point is clear, from the great length of time required to attain complete fusion. M. Ch. Schintz has also shown, by an elaborate calculation of the amount of heat carried into the regenerators and returned to the gases, that this should be the approximate temperature, and has verified his calculations by long and careful experiments. When we compare gas burning with dust burning, we may readily find abundant reason to expect, that by the addition of hot blast we may easily obtain in the reverberatory furnace a temperature fully equal to the Siemens. Messrs. Whelpley & Story heat the air blast by means of a stove quite similar in principle and general structure to that employed for blast furnaces, and located beyond the throat of their furnace, where it is heated by gases issuing from the hearth. Now, in the Siemens furnace the fuel is half burned, or more than half burned, in the generators, and the gases purposely cooled down in the great flue, in order to give them propulsion, and to condense the hydro-carbons, which would otherwise clog the regenerators. The heat so dispersed is a total loss, and it includes that derived from the perfect combustion of the greater part of the hydrogen, which has the highest thermal equivalent of any elementary sub-

stance; so that the entire heat of the hearth is derived from the combustion of nearly pure carbonic oxide, plus the heat received from the regenerators.* But pulverized fuel yields to the hearth the entire thermal equivalent of its compounds, which fact must go far towards compensating the effect of the regenerators; and we can easily compensate the remainder by heating the air blast, and this with the same expenditure of fuel as by the Siemens method. I see nothing in this application of hot blast which does not appear to be entirely practicable and simple.

I am able to certify that I have seen the foregoing results amply verified at the experimental furnace of Messrs. Whelpley and Storer, at Boston. There were charged upon the hearth 200 pounds of pig iron, which was melted in 17 minutes, to which were added successive charges of wrought iron scrap, amounting to 800 pounds, and the whole was tapped off in two hours and fifty minutes from the time of charging the pig iron. The ingots contained only about $\frac{25}{100}$ per cent. of carbon. The consumption of fuel was 177 pounds per hour of bituminous coal and anthracite slack, mixed in the pulverizer, and 29 pounds of anthracite culm in the fire-place. The hot blast stove was a mere temporary and imperfect affair, at no time above a just perceptible red heat, and yielding a blast certainly not above 450°; whereas, it might be made to yield readily 800° to 900° at the tuyere. Indeed, the temperature at command by this method is limited only by the ability of the furnace materials to withstand fusion, and this temperature is attained by burning a much smaller quantity of fuel than is required in the old reverberatory heating furnace for obtaining a welding heat.

The kind of fuel employed is an important consideration. The best results are obtained with bituminous coal. In common grate burning, anthracite usually gives a more intense heat than soft coal, although its thermal equivalent is theoretically less. But in burning soft coal, the distillation of hydrocarbon vapors from the upper layers of the fire absorbs considerable heat, and as these are subsequently burned only very imperfectly, and with great loss by smoke, much of the thermal power of this coal is lost. In the reverberatory furnace the long flame of bituminous coal is required to fill the hearth, while anthracite would yield only an intense heat in the

* The heat developed by burning C O to C O^2 should be greater than by burning C to C O, because in the latter case much heat becomes latent by vaporization, *i. e.* the conversion of a solid into a gas. The differences of specific heats are also in favor of the former.

fire-place, and a flame short and of small intensity in the hearth. With pulverized fuel the full, long, abundant flame, and the great temperature due to the higher thermal equivalent of bituminous coal, are both realized—a fact abundantly sustained by practice, and and in itself a proof that the combustion is more complete.

But very good results are attainable with anthracite, the chief ob-objections to it being that it requires more power to pulverize it, and that it does not ignite so readily. A slight admixture of bituminous coal will quicken the ignition very materially. Preparatory to pulverizing, the coal must be reduced to gravel, so as to enter the machine easily. This is done in a breaker or crusher, which is run at very small expense; a single crusher being sufficient for a large mill with many furnaces.

There remains to be considered what modification of the chemical effects of the flame would attend the use of pulverized fuel in the reverberatory furnace. There are certainly differences in the conditions under which the oxidizing or reducing influences of the flame are exerted, as compared with the old method. In the case of pulverized fuel, we have the entire mass of the coal, ashes and all, passing through the hearth. In some parts of the hearth we have free carbon and free oxygen uncombined, which sweep over the surface of the bath, and occasional particles falling into it. Somewhat similar conditions, but less in degree, attend the use of solid fuel, and I cannot but think that the effect of the pulverized fuel in carbonizing or oxidizing the metal will be determined by the conditions of the flame itself, *i. e.* whether oxygen or carbon preponderates. Although there is commonly present in the furnace both free oxygen and free carbon, yet the probabilities would seem to be that the metal would still be deoxidized when the oxygen is in any degree in excess of the demands for combustion, and would be carbonized when oxygen is deficient. In the case of puddling, the metal is powerfully protected by the supernatent slag. In heating iron piles, a neutral flame is obviously essential, and it would seem as if such a flame, charged with particles of solid carbon impinging against the soft white mass, would carbonize it. But if this were actually the case, how does it happen that the piles are not carbonized in the old way by the smoke, which abundantly fills the whole hearth, and is pure carbon in a spongy state, almost molecularly subdivided, and, therefore, seemingly in a condition most favorable for the production of this very effect. If such action can

take place any where, it certainly ought to take place in the puddling furnace immediately after balling, and just before the balls are drawn. The purified iron is then not only rolled up out of the slag, and naked to the flame, but is in that peculiar spongy state in which it exposes a very great surface to it, and is at the same time exposed to the highest heat. The abundant experience hitherto had with pulverized fuel shows no such action, and with a properly managed flame it probably does not occur. As to the use of this fuel for melting wrought iron and steel in open hearths, experience has not yet been sufficient to warrant a conclusion in this regard. In the experiments it would seem that the iron was carbonized to some extent, but the flame was overcharged with fuel.

II. *The use of pulverized coal in generating steam.*—The foregoing considerations are, with suitable modifications, applicable to boiler practice. As every fuel has the power of generating by combustion a fixed quantity of heat—a quantity which it is at present impossible to convert into its maximum useful effect by any method—the problem therefore becomes a question as to what is the method which will enable us to approach most nearly to this maximum useful effect. Part of the potential heat is never developed, because not all of the carbon and hydrogen can be oxidized, or rather peroxidized. Part of the heat developed by combustion is carried out at the chimney, and lost altogether, thus failing to exert any useful effect by absorption into the boiler. Part of the heat absorbed into the boiler is lost by radiation from the external shell before it can be converted into work in the steam cylinder—and so on; each source of loss being very serious, and robbing the engineer of a large per centage of his resources. The ultimate store of power which he is able to convert to actual uses is but a small per centage of the whole amount originally contained in his fuel. The use of pulverized coal involves a striking economy by the prevention of loss from two of the sources just mentioned, viz., from imperfect combustion and from failure to absorb all the heat generated. It does not indeed prevent *all* losses from these causes, but materially reduces them. The defects of the grate-burning method have perhaps been sufficiently discussed. Many attempts have been made to overcome them, and some valuable improvements have been accomplished, the most important of which are devices for admitting air over the fire. But, inventions intended to regulate the supply of air in conformity with the progress of combustion in the coals,

and those intended to consume smoke, have fallen into general disfavor, so far as economical results are concerned. They all involve inconveniences or losses which more than compensate their advantages. The essential conditions upon which a real economy of combustion must be founded are well enough understood, but the difficulty of attaining them has been inherent in the defects of the mode by which air and fuel are made to react upon each other. The admission of air over the grate is only a partial remedy, and fails to effect the one all-important condition of instantaneous and perfect intermixture. Considerable quantities of smoke and carbonic oxide have always been, and always must be, carried from the grate through the flues into the atmosphere, so long as this mode of firing is continued. But a source of loss quite different from imperfect combustion will appear when we come to examine into the conditions attending the transmission of heat from the gases to the heat-absorbing surfaces and interior of the boiler. In order that heat may be transmitted from one material to another, it is necessary that the temperature of the two be different, and the rate at which it is transposed will be a positive function of this difference. Again, the transmission of heat through a plate of metal requires time, and the longer the heat-giving body is in contact with the plate, the more heat will be transmitted. It has been stated that the average amount of air supply to the grate is at least twice the theoretical quantity necessary for complete combustion. This amount is found practically to give the best results, on an average, with that method of firing. Let us assume, as no doubt can be easily shown in practice, that the air supply for pulverized fuel need not be more than fifty per cent. in excess of the theoretical minimum. We have at once a diminished volume of escaping gases, and a corresponding increase in their temperature. In effect, then, we have a largely increased difference between the temperatures of the two sides of the plate, and an increased transmission. But this is not all. The rate at which heat is transmitted, increases in a higher ratio than the difference of these two temperatures. For example, let us take two cases, one of a plate whose interior surface is in contact with water at 250°, and its exterior in contact with gases at 1000°; the other of a plate whose interior is in contact with water at 300°, and its exterior in contact with gases at 1300°. Now, not only will the transmission be absolutely greater in the second case than in the first, by reason of the wide difference of temperature in the two sur-

faces, but it will be *greater for each degree of difference.* Again, a reduction in the volume of gases implies a corresponding reduction in the velocity with which they pass through the flues, and therefore increases, in the same ratio, the time during which they are in contact with the heat-absorbing surfaces.

It must be borne in mind that the advantages here indicated are not peculiar to pulverized fuel alone, but are applicable to all flames of a high temperature. The superior economy of high temperatures over lower ones (so long as they are not destructive to the boiler or fire-chamber) is a principle susceptible of the fullest demonstration.

The foregoing discussions are by no means wholly new. The principles and facts involved in grate-burning have long been understood to be substantially as stated, and have been practically assumed in all rational attempts to construct smoke-burning fire-boxes. Mr. Bourne, in his great treatise on the steam engine, has illustrated and discussed them in his descriptions of numerous contrivances for this purpose. The abatement of the smoke nuisance is one of the great problems of English mechanical engineering, having been made the subject of innumerable patents and several parliamentary investigations. But such investigations seem to have ended just where they began—in smoke. Hence, no doubt, Mr. Bourne was led to make the following significant statements: "Nearly all the expedients hitherto introduced for burning smoke in locomotives, are adaptations of the devices heretofore in use for burning smoke in land-engine furnaces. But the rapid combustion which a locomotive boiler requires, renders the burning of smoke by any of these ancient devices a matter of very difficult achievement, and it seems to be indispensable that a method founded on a totally new principle should be introduced. It appears to us that the fuel and the air must be fed in simultaneously; and the most feasible way of accomplishing this object seems to be in reducing the coal to dust and blowing it into a chamber lined with fire-brick, so that the coal dust may be ignited by coming in contact with red-hot surfaces after having been mingled with the quantity of air necessary for combustion. This, however, in common with other improvements upon the locomotive, requires to be worked out."

The foregoing discussions have been based upon the assumption that the conditions of burning pulverized fuel are realized in the manner calculated to yield the best results. The present stage of this invention lacks, as yet, some few requisites of completeness,

and is by no means without practical difficulties. Of these, the most important relates to the manner of igniting the dust. It would seem that, in order to be perfect in its action, the flame of the fuel should be self-sustaining, and keep up the ignition steadily from the mouth of the tuyere, without any adventitious aid from a gas generator. If the gas generator be removed while the fire is under full headway, there will be no falling off in the flame at first. On the contrary, if the supply of air be regulated by the requirements of the coal, the heat will be more intense, but at the same time the point of ignition will slowly push forward into the furnace, and the brickwork around the tuyere, being thus removed from or abandoned by the flame, will cool down. Now, it might seem as if this could be remedied by diminishing the velocity with which the fuel and air are poured into the furnace, which might be done by increasing the aperture of the tuyere. Supposing this to be practicable, instead of having a constant position where the ignition would commence, that position would be one of unstable equilibrium, in which a slight variation of circumstances would cause the flame either to advance into the furnace or recede into the pipe. In a word, it is necessary to determine definitely the point of ignition, and there seems to be no way of doing it better than by bringing the coal in contact with burning gas. Now, the generator, which accomplishes the ignition, is otherwise detrimental to the highest effect of the fuel, since, so far as it goes, it reproduces all the disadvantages of grate-burning, with its excessive supply of air, which takes up heat and diminishes temperature. But since it is made very small—as small, indeed, as practicable—its effect is correspondingly small in diluting the effect of the fuel. It is to be hoped, however, that the rare ingenuity of the inventors will enable them to discover some equally certain means of igniting the fuel without even these small disadvantages.

In conclusion, there is appended the statement of Messrs. Whelpley & Storer, of the work performed by their pulverizers.

"The 18-inch pulverizer, commonly applied to furnaces, reduces 200 pounds per hour of anthracite coal, the proportions of size being about like the yield of mill-stones. It requires about 3½ horse-power to effect this. The same power reduces 300 pounds of bituminous coal, a large proportion of it being very fine. The entire yield will burn easily, wafted through a hot furnace. A 42-inch pulverizer, requiring about 15 horse-power, will deliver 1000 to

1200 pounds of anthracite per hour, 2000 pounds of bituminous coal, 2500 to 3000 of quartz, 2000 to 2500 pounds of top cinder, 3500 to 4000 pounds of limestone, 900 pounds of unburned bone, and 50 bushels of wheat. With an increase of power we have ground one bushel of wheat per minute, finer than is done with mill-stones, and 6000 pounds of copper ore in limestone gangue."

"A comparison of these figures with stamp-work, or any other method of pulverizing, would show very great economy, whether in cost of machines, attendance, wear and tear, or power consumed."

WOOD-WORKING MACHINERY.

A treatise on its construction and application, with a history of its origin and progress. By J. Richards, M. E.

(Continued from Vol. LXI, page 315.)

Cutting.—"In the sweat of thy brow shalt thou eat thy bread," was the judgment pronounced against man. A kind Beneficence has, however, so constituted mankind that his normal condition is one of labor; and, instead of a judgment, labor and industrial activity is the greatest of human blessings.

The materials of nature that are needed for our comfort and existence are not placed in our hands ready for use, but have to undergo processes and a "making up" to adapt them to our wants.

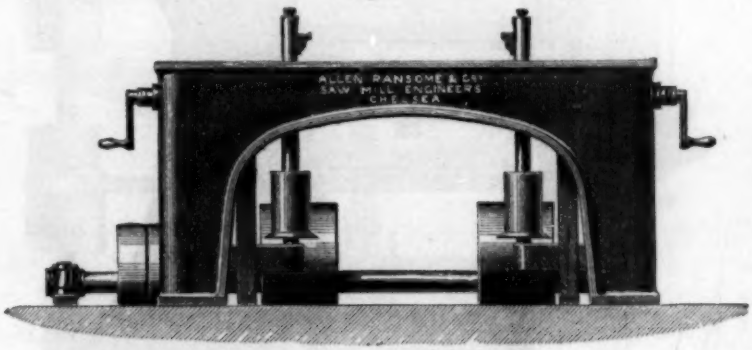
In those things that are continually essential, and without which we could survive but a brief time, nature has kindly adapted them more nearly to our wants, without previous preparation. Air, that is momentarily needed, is not left contingent upon our exertions, but is free to all, and ready for use. So with water, which needs but transmission to where it is wanted. In this we see a wise purpose. These things are too important to be left to anything so uncertain as human effort to prepare and change.

Not so with our food and clothing and other wants. We must have an agency in their preparation. They are furnished to us in a crude form, to be worked out by skill and manual effort, directed by our intelligence.

To ameliorate the laborer's toil, that would otherwise be needed in converting these crude products of nature to our uses, we are supplied with the natural forces, taking the place of our hands.

Steam alone has relieved man of nearly all his drudgery. It produces his clothes, his food, transports him from place to place, exchanges the products of various parts of the earth, so that in each part is enjoyed the benefits of the whole. Glance around a room fitted with the comforts of life, and see if there is anything that does not in some manner owe its origin to steam. Not a thing will be found—books, paper, even the ink and pen with which we write, the very buttons on our clothes—but can be traced back to this mighty agent of production.

Fig. 1.



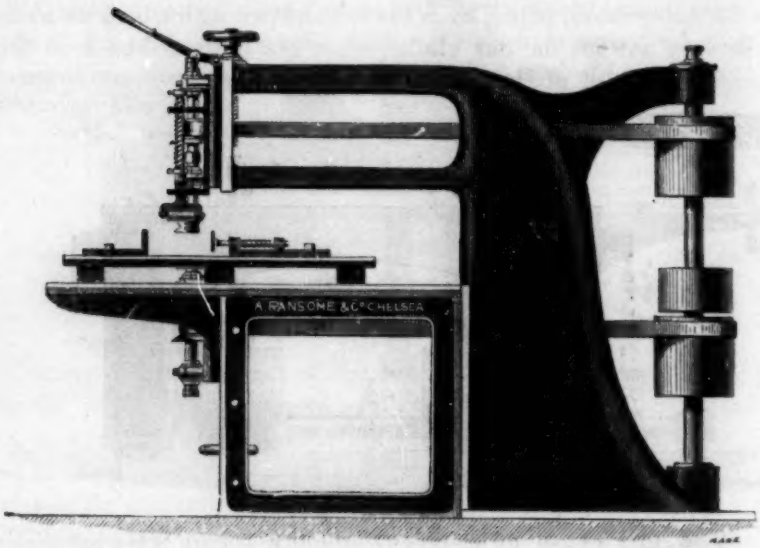
Wood and metals, to which our attention is here more especially directed, come to us in such a crude state that but little if any benefit can be gained from them until wrought by our industry. The trees in the forest or the ores in the earth are far from contributing anything in a direct way to our wants; they must be grappled with by force, and by the light of science be artificially wrought into the thousands of forms that we see around us.

To come to something more practical after these general propositions, it is proposed to consider the cutting and shaping of metal and wood as constructive material.

The processes are surprisingly simple when considered in the abstract. For metal we have molding and compressing the material in a malleable or melted state, removing the surplus by means of the wedge or cutting tools, and by abrasion. The latter can, no doubt, in a sense, be considered the same as cutting or the wedge action, if followed to a nice distinction, but for the sake of classification will be spoken of as a separate means of shaping material. By molding and forging accurate dimensions can be obtained. The

excessive heat and expanded condition precludes any certainty of dimensions when the metal cools, even if other conditions were favorable; hence the process is but a preliminary one at best, in which an excess of metal must be allowed to be cut away.

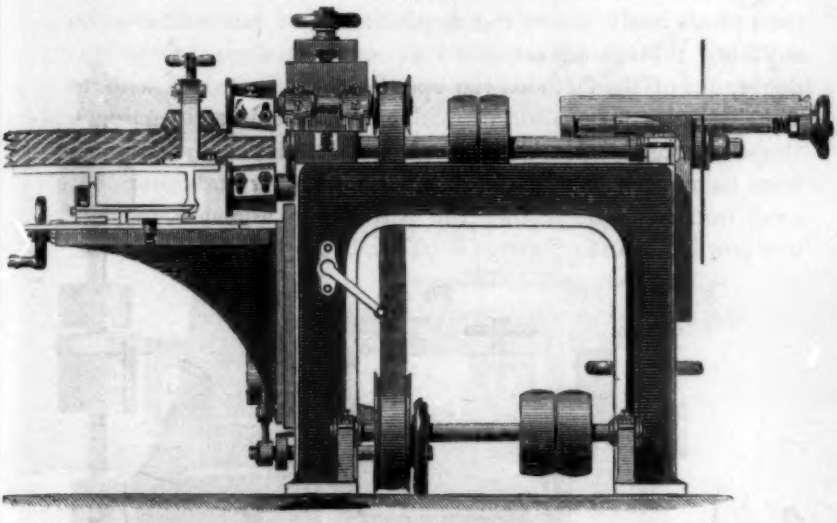
Fig. 2.



In shop practice there has not been (so far as the writer knows) any data from which to draw conclusions upon the relative cost of preparing or shaping by means of cutting tools as compared with grinding, which we will, for distinction, class under the general head of "abrasion." It is true that when material is too hard to be cut we grind it—with sand, emery, or by frictional abrasion—from necessity; but supposing, for example, that we have 10 pounds of soft steel to remove from a cylindrical shaft, or from a plane surface, "is it cheaper to cut it away with wedged tools or to grind it off?" This is not a chimerical proposition, but one that enters directly into practical manufacturing. The writer, in 1864, built a machine for grinding, that corresponded in its functions to the metal planing machine. The stones used were seven feet diameter by 12 to 16-inch thick; the traversing carriage was 8 feet long, 18 inches wide, weighing about 1 ton. This carriage was mounted on rollers, and had a reciprocating motion of 6 feet per minute, equal in speed

each way. The mechanism corresponded in general to that of an iron planer, or as near as practicable, considering the peculiar arrangement that was necessary to protect the movable joints and bearings from the sand and grit.

Fig. 3.



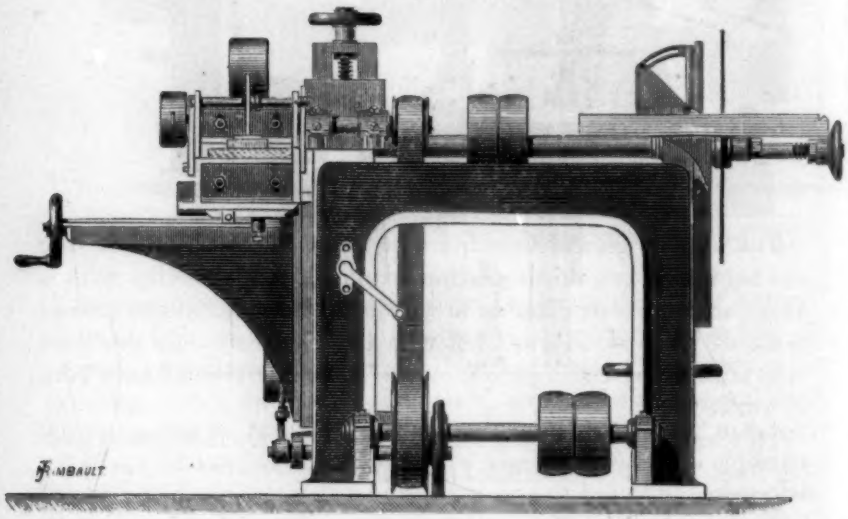
The surfaces ground were from the forge, composed of soft iron and hard steel, two-thirds of iron to one of steel, covered with a heavy scale from oxidization in welding. The material was ground to a true plane surface, and left with a polish that could not have been attained by cutting tools, even if the material could have been so worked.

This machine has been constantly at work since that time, grinding from 75 to 100 superficial feet per diem.

It is, of course, impossible to institute any comparison between this performance and that of a planing machine, unless we assume some specific work to be done, and whether the work is to prepare plane surfaces, removing only the irregularities of rolled plate or bars, or whether it is to cut away a large amount of material. Assuming, however, that the same pieces could have been planed, the work performed is at least eight times as much as could have been done with cutting tools on a planer. To offset this we have the greater amount of power used, say 25 to 1, the wear of the stone amounting to $2·50 per diem, or as much as attendance—the greater room

needed for grinding machinery, its dangers, and the very serious objection of the sand and water that finds its way all over the shop—the rapid wear that cannot be avoided in such machines; so that there is, after all, perhaps, nothing gained in grinding plane surfaces that can be planed. A popular impression exists that it is much cheaper to grind than to turn or plane soft iron or steel—a mistake that will soon prove itself where the displacement of material amounts to anything that could be called a "cut" for tools. It grows, no doubt, out of the fact that the speed is not limited, as with tools, and that a greater amount of work can be done in a given time with the same attendance. This is only possible because of the conditions being such as to avoid heat, as it certainly costs more to cut away iron by disintegrating the particles by abrasion, reducing it to a powder, than to "wedge it off" in large pieces.

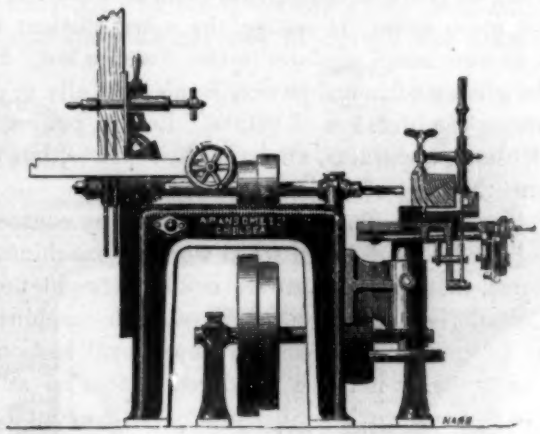
Fig. 4.



The "wedge" is man's great agent in converting the materials of nature to his uses. In working wood we can neither grind nor forge; all operations are simple cutting, and the wedge alone can be used. From the felling of trees by means of the axe down through the thousands of forms into which it is wrought, the cutting edge is the only means of dividing and shaping wood. The whole system of wood cutting machines represents only the various plans of applying the wedge.

It is both curious and interesting to resolve simple munipulation into this somewhat abstract proposition of a wedge, but it is true, nevertheless, and the most important deductions in practical matters are not unfrequently drawn from such propositions. In a recent law suit, involving a large expenditure of money and time, the position of the defendant was based upon a supposable difference between a cutter head and a circular saw. One of the suits growing out of an infringement upon the famous Woodworth patent, in wood planing machines, was from a similar mistake. Now, had this proposition, or rather fact, of all wood-cutting tools working on the same principle, been understood, or even suggested, a great loss of money and time could have been avoided.

Fig. 5 (front.)



Again, considering all wood-cutting machines as acting on the principle of a wedge, it leaves but two essential conditions to be determined, in order to find what kind of cutters are best adapted for any special kind of work: first, the angles of the cutter; and, second, the relation between the edge and the course of the fibre. The teeth of a saw, for instance, that is used for cross-cutting, require to be very different from one that is used for slitting. The cutting principle is the same—the simple wedge—in both cases; but the question of fibre comes into play. The lateral adhesion of wood fibre is comparatively weak, and but little force is required to split it off when the ends are severed. This is illustrated in the process of splitting wood longitudinally into fire-wood or fence-rails. In

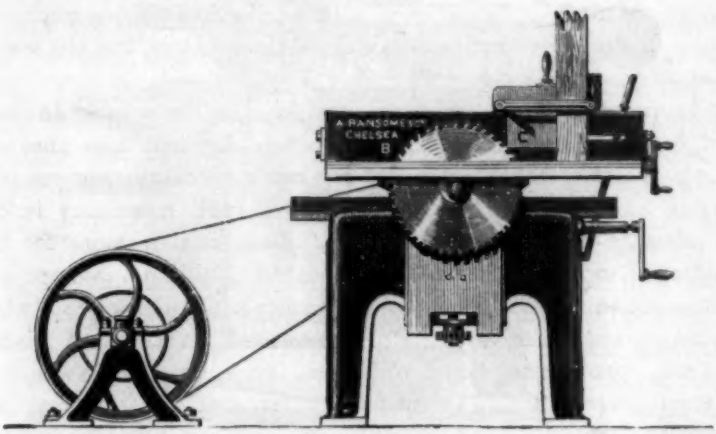
the saw for cross-cutting the teeth must be so arranged as to sever the fibre at the end before removing particles. In slitting, the teeth must be arranged with reference to severing the fibre across the width of the kerf with each tooth. To do this with the least power, the angles of the tooth must be as acute as possible, must correspond to the action of a chisel for mortising. As a general rule for all cutting edges in wood work, they should be as thin or acute as possible, the degree, of course, being governed by the hardness of the wood and the transverse strain that may fall upon the edge. Following out our hobby of the wedge, without any attempt at connection, it will be remarked, that vessels for navigating the water furnish another example of its importance. A vessel, to carry a certain amount of load, must have a certain amount of immersed section. This we put into the general form of wedge, to divide the water. The more acute the wedge, the more efficient its action. Projectiles, as now made, conform to the "wedge law," in that the wedge is the great mechanical power, man's chief ally in combating and overcoming the obstacles of nature. Levers, pullies, explosive agents, hydrostatic apparatus, all have their places, but the wedge is paramount, the king of all.

Shaping Machinery.—The term shaping has, by consent and custom, been adopted to define all wood working machines that cut irregular forms, that is, lines that are neither straight nor yet true curves. Considering the importance of such machinery in the manufacture of gun-stocks, lasts for shoes, oval sections for the handles of tools, &c., it is to be wondered at that no attempt had been made to do such work by machinery until about 1820, when the Blanchard Lathe, in some form, appeared in the United States. In 1822, John Parker Boyd, of Boston, Mass., patented in England "Certain improvements in machinery, for shaping or cutting out irregular forms in wood or other material or substances which admit of being cut out by cutters or tools revolving with a circular motion, whether such motion be 'continuous' or 'reciprocating.'"

The machine illustrated in the drawings that accompany the specification in this patent (No. 4652) show what is known as the handle-lathe, constructed in all essential points as it is now made. We refer to the English patent instead of the American, for the reason that it is *available;* and it will be proper in this connection to say, that while the abstractions of patent law are so thoroughly considered there it would be as well to study the plan which the British Go-

vernment and continental countries have adopted to give publicity to patent inventions. Certified copies can only be procured here after delay, and by paying from ten to twenty times their worth. For this reason it has been found necessary in these papers to use, as far as possible, English patents for reference, which, we feel ashamed to acknowledge, are more accessible, and, as a rule, are much more clear and comprehensive in their specifications. The writer can confidently state, from his own experience, that it is easier to examine ten patent specifications in the British Office than a simple one at Washington, where there is but a simple drawing and single copy of the description, and these, strange to say, kept in separate rooms. It is true some reform has been made by the recent innovations—the specifications are printed and the drawings photographed; but why not throw the whole thing aside—compile and print our specifications and lithograph the drawings, as the

Fig. 5 (side.)



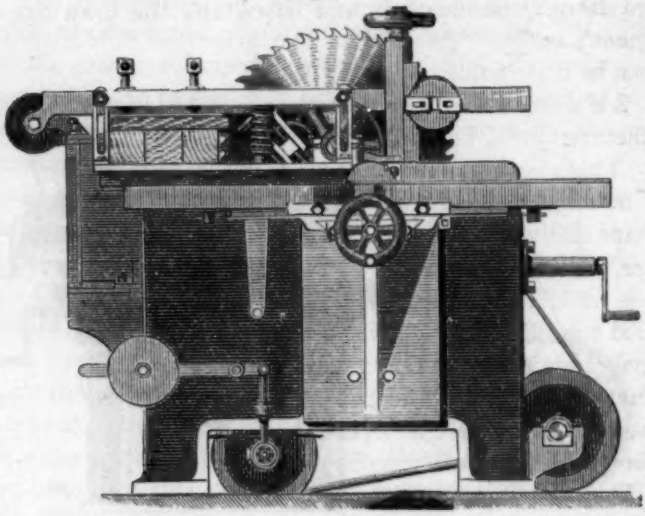
English do? The saving to the country in litigation that would be avoided in a single year would go far towards paying the expense.

To resume. Irregular shaping consists in producing duplicates with a cutting tool and tracer that have coincident movement. Duplicating machines would be a better and more comprehensive name for tools of this kind, and should be adopted. For turning handles, gun stocks, lasts, &c., the material is placed in a swinging lathe that has a radial motion on a pivot. The vibrations of the lathe are produced by a duplicate of the piece to be cut, which revolves in con-

tact with a guide or tracer that corresponds to the cutters, acting on the piece to be worked. In the later and best modifications of these lathes, the cutters vibrates and the material revolves on fixed centres—the principle being the same, with the advantage of vibrating a lesser weight. If the digression will be excused, we will here note that there is an obvious law of construction disregarded in many machines in this respect of relative movement.

Always move the parts that have the least weight, is a rule that will be found right in nearly all cases. When the material is heavier than the tools, move the tools, and vice versa. There are, of course, other conditions beside weight or resistance to be considered; still, the rule is a good one, and applies, with but few exceptions, to all other wood machines as well as the eccentric lathe.

Fig. 6.



Duplicating from patterns by means of cutters and guides was, during the term of the Boyd or Blanchard patent, subject to a tax from the users, whether in the form of the swinging lathe or with moveable tools, and it is somewhat strange that during the first term of that patent, the principle, as we will term it, did not come more into use. The shaping machine has always been regarded as a distinct invention, although its performance is much the same, except that it cuts in a constant plane. Fig. 1 is an edge-shaping, machine, a true front elevation $\frac{1}{2}$ inch to 1 foot, from the designs of

the manufacturers, Allen Ransome & Co., of London, England, who have kindly furnished many engravings which have from time to time appeared in these articles. This machine has recently been modified and improved, and another engraving will be presented in a future number of the *Journal*. The spindles have a vertical adjustment by means of screws and gearing, operated by the cranks shown on the right and left of the cut. The spindles are reverse motion right and left; weight, 3000 pounds; cutting speed, 4000 feet per minute. The cutters, it will be noticed, are passed through slots in the spindles, which gives a cutting angle too obtuse for soft wood, but has claims for convenience and simplicity that quite balance this fault, especially where a great variety of cutting is done—a single cutter being used. The common plan in this country is to use two duplicate cutters on each spindle, held by clamping collars that are screwed down upon the edges or ends of the blades, by which arrangement a perfect "balance" is maintained, and the angle of the edge can be more acute.

Fig. 2 is a side view of a machine of the same class, from the same manufacturers, that has two spindles, one above and one below the piece. This machine is adapted to such a variety of uses that it would be impossible to enumerate them here. There is scarcely any shape that cannot be attained, either for ornamentation or fitted surfaces. Carving in relief is, however, the main object, a work which is rapidly performed in a very perfect manner. The design is a good one. The great "overhang" of the spindle throws a heavy torsional strain on the main column or support, which is peculiarly constructed in order to withstand it. The weight is 3000 pounds.

Figs. 3, 4, 5 and 6 are true elevations of combination machines for joiner work, manufactured by Messrs. Ransome & Co., of London. They are capable of doing an endless variety of work by changes of cutters, and the complex adjustments that have, by experience, been from time to time added. Their work is, however, in straight lines. Mortises, tenons, grooves are made; sawing, planing and molding can be done. In fact, the requirements of a small shop or the "odd jobs" in a large shop can all be done on the general joiner, as it is termed, with great facility.

(To be Continued.)

BELTING FACTS AND FIGURES.

By J. H. Cooper.

(Continued from Vol. LXI., page 319.)

The belt offers a simple and efficient means of producing intermittent effects, as in that of operating stamps, when it is desirable to control by the hand the number of blows in a given time, as well as to vary the intensity of the same at will. Arranged in this manner it acts as a friction clutch.

In Fig. 3, the shaft J, which may be the main line of the shop, or a counter shaft, carries a flange pulley H, continuously revolving in the direction of the arrow. Over this pulley is thrown loosely a belt D, one end of which is fastened to the stamping weight A at E, and the other end is secured to the floor at F.

The weight A is guided in the parallel uprights B B, and rests upon the base C. As the apparatus stands, the weight A is not lifted, owing to slackness of the belt, but by taking hold of the belt at G by the hand, and drawing it forcibly in a horizontal direction and at right angles to the shaft, a severe tension is created in the belt on the pulley, which latter lifts the weight at a velocity nearly equal to that of its rim; releasing the belt from the hand destroys the tension, when the weight falls freely back to the base.

It is evident that the number of blows struck may be repeated at will, and that the force of the blows, in so far as they may be due to the height of the fall, may also be regulated by the duration of the lateral pull on the belt.

Since the effect of the lateral pull on G is as G F + G H, and becomes less as it leaves the straight line joining H and F, it is important to make the distance H F as great as may be convenient, and to keep the belt as taut as can be without destructive friction on it at the pulley surface when not in use.

For the lighter hand stamping operations, this is a simple, cheap and ready means of obtaining gravity effects on dies and molds.

The Lincolne Belt-fastener.—"The disadvantages, such as insufficient strength and loss of time attending the usual mode of fast-

ening belts by means of sewing or of leather laces, are well known. What worker in a mechanical workshop has not had to do with the comparatively tedious operations of lacing a belt? Several mechanical belt-fasteners are now in use. One of the newest and most ingenious forms, affording a very strong and yet light joint by very simple means, is that which we now illustrate. It is a Canadian invention, and we understand that, though of very recent introduction, it is making rapid headway, both in England and abroad. The fastener consists of two pieces of tough curved plate (Figs. 1 and 2), tinned, to preserve them from oxidation. The buckle proper is curved, as shown in the cut (Figs. 1 and 2), and formed with a series of teeth at each side, its width transversely to the length of the belt being rather less than the width of the belt itself.

The ends of the belt are pierced with an awl, or a special tool for the purpose, from the inside, in a somewhat slanting direction, and the points of the teeth are inserted in these holes through the whole of the belt, so as to project at the opposite side to that at which they are inserted. The plate cover or clasp proper is then slipped over the projecting teeth, of course tying them securely fast, and making the complete buckle. With very wide belts several such buckles are applied. Such a joint is clearly as applicable to india rubber, gutta-percha, or woollen belts, as to those of leather."—*The Engineer, Jan.* 27, 1870, *p.* 56.

Belts for Rolling Mills.—"Nearly all rolling mills in Pittsburgh are driven with belts, from 20 inches in breadth upwards; something like the proportions may be guessed at from the following: One mill has a pulley 26 feet diameter, 66-inch face, with two 32-inch belts running to a pulley overhead, about 8 feet diameter. Another is 25 feet diameter, 45-inch face. Engines with such wheels and belts are being built every day, giving great satisfaction.

"The question of driving rolling mills with belts might be dwelt upon, but its advantages must be apparent to any practical man."—*The Engineer, March* 4, 1871, *p.* 213—*Englishman.*

Dressing for Leather Belts.—"One part of beef kidney tallow and two parts of castor oil, well mixed and applied warm.

"It will be well to moisten the belt before applying it. No rats or other vermin will touch a belt after one application of the oil.

It makes the belt soft, and has sufficient gum in it to give a good adhesive surface to hold well without being sticky.

"A belt with a given tension will drive 34 per cent. more with the hair side to the pulley than the flesh side."

F. W. BACON, N. Y.

An engineer of considerable practical experience with machinery replies to queries thus:

Rule for horse-power of a belt—

$$\frac{\text{H. P.} \times 26000}{\text{V} \times \text{C} \times 6} = \text{W}.$$

In which H. P. = horse-power.

V = velocity of belt in feet.

C = circumferential contact with smaller pulley in feet.

W = width of belt in inches.

"Single belts have given us the best satisfaction, taking less power to drive them, and adhering to the pulleys much better, and do not crack in bending.

"The area of belt contact determines its driving power.

"For fastening the ends we consider hooks the best for small belts. For large belts we use hooks, with the addition of a piece of leather rivetted over the lap.

"The best composition for preserving belts and giving them adhesion, is oil with a small quantity of rosin in it.

"Thin belts are better than thick ones.

"The convexity of pulleys should be the least possible, not over $\frac{1}{8}$ inch to the foot of breadth."

Another engineer gives the following:

"To find the number of horse-power which a belt will transmit, multiply the number of square inches of belt contact with the pulley by the velocity of the belt in feet per minute, and divide the product by 64000."

A skilful machinist, of much experience with experimental machinery, says:

"In answer to question 8, the best method of joining belts that I know of is by the ordinary lacing. The holes therefor should be punched about three-quarters of an inch apart, or as near that as the equal division across the belt will allow, and for wide belts two rows of holes should be punched, in a zigzag direction, commencing with the lace in the middle of the belt, and lacing singly to each edge, returning to the centre and securing the ends, crossing the lace on the outside of belt.

"I have found this plan preferable to the one generally adopted, that is, of lacing double at once across the belt finishing at one edge, the objection to which is in the loosening of the ends of the lace and yielding of the joint at one edge, which will crook the belt and render it liable to lateral running, off the pulleys, against flanges, into gear perhaps, and may permanently stretch the belt so unevenly as to make straight running again matter of impossibility.

(To be continued.)

THE PENNSYLVANIA RAILROAD SHOPS AT WEST PHILADELPHIA.

By Joseph M. Wilson, C. E.

[P. A. Engineer, Construction Department, Pennsylvania Railroad.]

(Continued from Vol. LXI. p. 102.)

West Blacksmith Shop.—This building, designated No. 3 on Plate I., is intended to accommodate all smith work at these shops connected with repairs in the motive power department, and hence its close vicinity to the locomotive and machine shop. Its outside dimensions as seen by the plan, Fig. 1, Plate IX., are 162 feet 9 inches by 70 feet, affording an inside floor area of 10,626 square feet. It is unnecessary to go into any details respecting the construction of the walls of the building, the doors, windows, &c., as it would be merely repeating what has been mentioned previously for the locomotive and machine shop. The roof truss, however, is different in some respects. The principals are placed 16 feet 4 inches apart, centre to centre, being framed as shown in Fig. 3, Plate IX. The number and size of the different timbers, and the diameters of the vertical tie rods are given on the Plate. The angle blocks are numbered, the numbers as marked on the elevation of the roof, corresponding to those given in Fig. 3, Plate VI. The purlins are 5 by 8 inches section placed three feet apart, and the ventilator is provided at the sides with open slats instead of glazed sash, so as to furnish free egress for any smoke that may accumulate in the upper part of the building, and afford thorough ventilation. As regards the details of connection of the different parts of the roof, the roof covering, drainage, &c., they are the same as given for the locomotive and machine shop.

The building contains twelve double brick forge fires, of which Fig. 2, Plate IX, shows the construction. Each hearth is 5 feet 2 inches long by 4 feet 6 inches wide and 1 foot 11 inches high, having a curved front. The top is protected around the edge by a flat wrought plate $\frac{5}{8}$ by 4 inches section, well secured by anchor bolts to the brickwork. Five courses of brick are laid on the hearth to form the back, and on these the brackets for supporting the hood to the fire, are set. These are $\frac{3}{4}$ by 8 inches section, curved as shown. At the top they are anchored back into the brickwork by wrought plates $\frac{5}{8}$ by 8 inches, and the brackets of a pair are connected in front by a tie bar 1 by 3 inches section. The hood is then carried up in brickwork, the opening of the flue being as shown by dotted lines on the Plate. The back for the fire is of fire brick. The flues are built on an incline, approaching each other until they meet some distance above, forming a figure like an inverted V. They are then carried up vertically to a height of 20 feet above the ground, where the brickwork stops and both flues are run into a circular sheet iron stack, 2 feet in diameter and 21 feet high, surmounted by a ventilating cap. Wrought plates and tie rods are used at two places below where the chimneys meet, to bind them together and counteract any thrust which may result from their inclination. The blast is driven by a No. 8 Dimpfel Patent Blower. The blast pipes are laid in two lines, one under each row of fires, both lines coming together before reaching the blower. They are of cast iron, with planed flange connections, and vary in internal diameter from 10 inches at the blower to 4 inches at the farthest extremity. From the main pipe a 4-inch double branch pipe goes off vertically under each pair of forges, throwing a blast into each fire. Each branch has a valve to properly regulate the amount of blast, and terminates in a $2\frac{1}{2}$-inch copper pipe, which passes into the tuyere. The tuyere is of cast iron, made hollow, and kept cool by a circulation of water through it, being connected by two lead tubes with the water tank shown in the Plate between the fires and above them.

In addition to the forge fires described, this shop also contains the following: No. 1 is a heating furnace, built by Matthews and Moore, and very useful for working up scrap. No. 2 is an open forge, for heating large forgings. Nos. 3 are cranes, the largest not lifting over two tons. No. 4 is a Thwaites & Carbutt steam hammer, of 1500 pounds weight, and No. 5 is a hammer by the same

Pennsylvania Railroad Shops
West Philadelphia
Blacksmith & Boiler Shops

Scales.

Fig 1. Feet
Fig 2. Feet
Fig 3. Feet

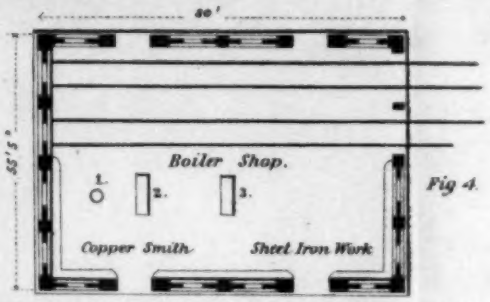


Fig 4.

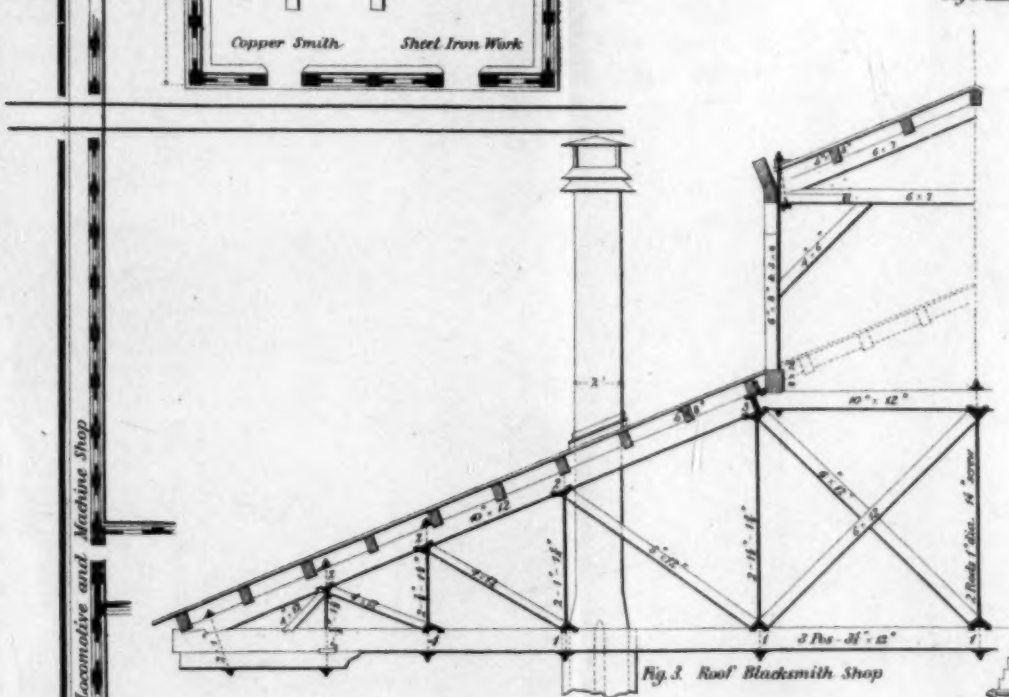


Fig. 3. Roof Blacksmith Shop

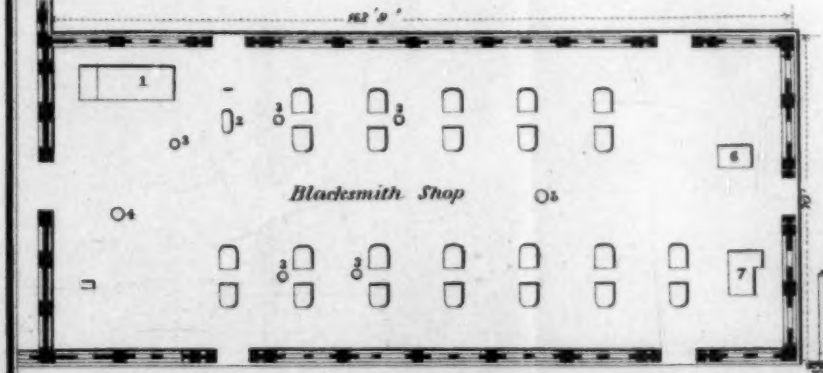


Fig 1.

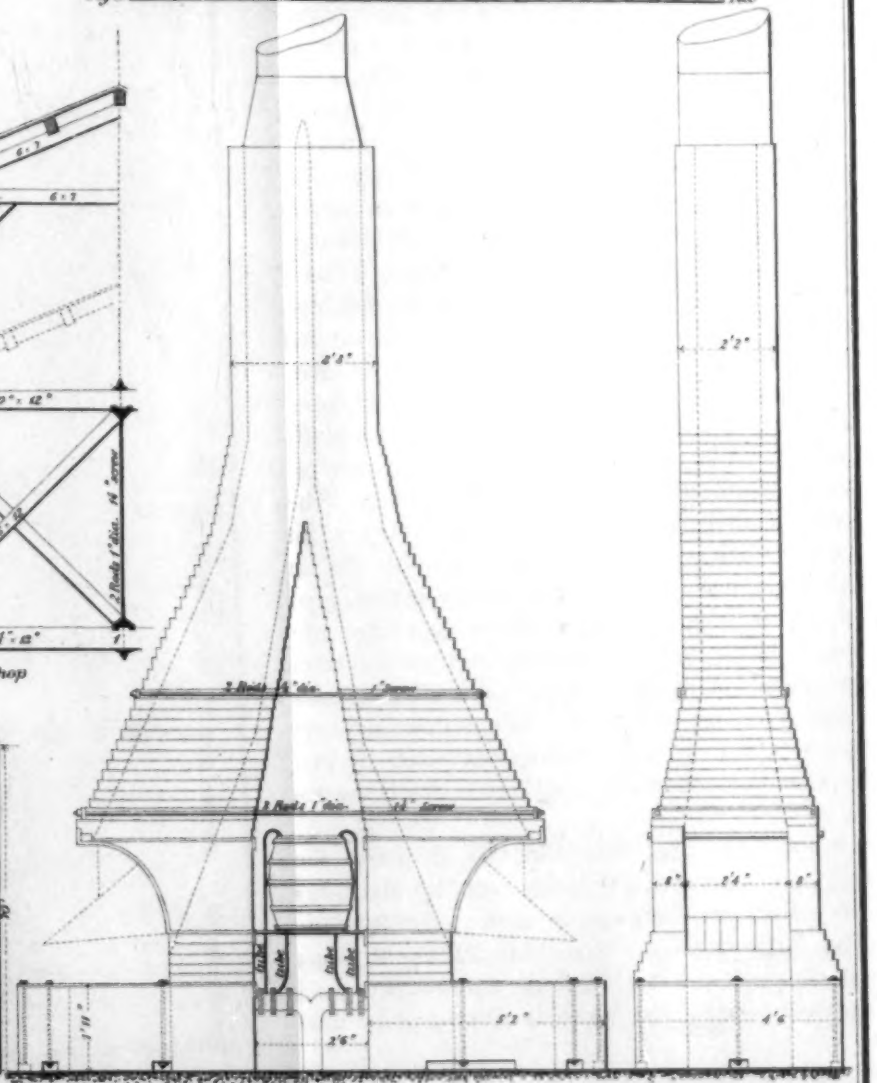
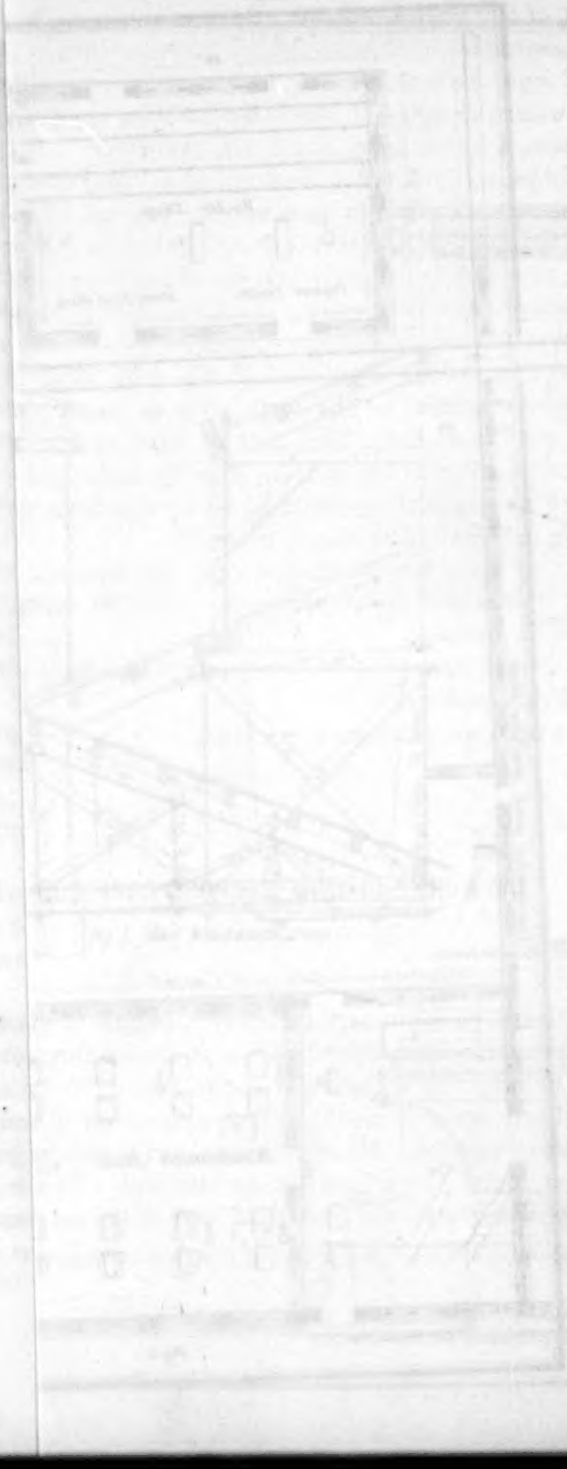


Fig 2. Blacksmith Fires

Construction Dept Penn.a R.R.



makers, of 800 pounds weight. No. 6 is a flanging forge and furnace, constructed on Nixon's Patent of June, 1868. The forge is built of iron, the bottom being double, and kept cool by a circulation of water through it. The holes for blast are distributed over the bottom, 4 inches apart, and a fire can either be built over the whole forge, or, by temporarily stopping as many of the blast holes as necessary with small rivets, a smaller fire can be used. On the floor in the space around this forge are placed the various forms for shaping sheets of boiler plate into the different parts of the boiler and fire-box of the locomotive. No. 7 is a case-hardening furnace, and a reverberatory furnace for springs.

Boiler Shop.—This shop, marked No. 4 on Plate I, is a brick building, constructed in the same style as those previously described, and has an inside floor area of 3914 square feet. It has two tracks, one for boilers and the other for tanks, and contains the necessary accommodations for copper and sheet iron work, and the following machinery (see Fig. 4, Plate IX):

No. 1. An open fire, for use of copper and tinsmith.

No. 2. Punch and shears combined; clear, 20 inches. William Sellers & Co., makers.

No. 3. Set of hand rolls, 78 inches long, 9 inches diameter. Wm. Sellers & Co., makers.

Also, a drill, not marked in the Plate.

(To be continued.)

ON A SHIP CHANNEL ACROSS CAPE COD.

By Jos. P. Frizell, C. E.

(Continued from Vol. LXI., page 391.)

The River Clyde,* from the Port of Glasgow to the Sea, offers one of the most remarkable instances of the employment of tidal currents in deepening a channel. In the year 1755 John Smeaton examined and reported upon the Clyde with a view to the improvement of its navigation. His report speaks of it as a very irregular stream varying in width from 400 to 1400 feet. The depth in the vicinity of Glasgow at the period of high tide was but 3 feet 6

* The following historical sketch is from the Life of Thomas Telford, pages 492, 501.

inches, allowing only the highest barges to approach the city. The prospect of deepening the channel of the stream appeared so unpromising to him, that he recommended the construction of a weir and lock, at a point below the city into a basin. He hoped by this means to enable vessels of 6 feet draft to reach the city. This recommendation was not adopted.

In 1768, in accordance with the advice of J. Golborne, it was decided to attempt the improvement of the depth by means of wing dams projecting from the shore, their purpose being to quicken the current by contracting it. This method was first put in practice in 1772 at Dumburk Ford. The channel was contracted by means of wing dams to a width of 300 feet. The results exceeded the expectations of the projectors, and the method was applied to the entire stream so far as it required deepening. In 1807 Rennie advised the construction of parallel dams omitting the heads of the wing dams, which recommendation was adopted, and works executed in accordance therewith, wherever the wing dams were not sufficiently close to one another to have the desired effect upon the current. By a report of John Clark, in November, 1824, it appears that vessels of 11 feet draft could enter the Port of Glasgow without difficulty at high tide. About this time a permanent force of dredges was put in operation at localities where from the refractory character of the bottom or other circumstances, the method of quickening the current was not effective. By a report of James Walker, in 1836, it appears that points in the vicinity of Glasgow which formerly had a depth of 16 inches now had a depth of 7 or 8 feet at low tide. That the tide at Glasgow which formerly was hardly observable, now amounted to 7 or 8 feet at spring tides, and 4 feet at neaps.

*At present the Port of Glasgow is accessible to vessels drawing 17½ feet, and one significant fact is to be noted in this connection, viz: that the entire cost of these improvements up to a recent date extending over a channel some 20 miles in length and embracing nearly a century of time, including much fruitlessly spent upon the wing dams, and also the quays at Glasgow necessary for the accommodation of its enormous trade, has amounted to a less sum than was estimated for the C. C. Ship Canal†. One of the ablest of modern hydraulic writers‡ says: "The remarkable increase of

* Lippincott's Gazetter, art. Glasgow.

† Lippincott's Gazetter, art. Glasgow.

‡ G. Hagen, Wasserbaukunst, Zweiter Theil. Die Ströme, Vol. II., page 247.

depth in the Clyde is due solely to the strengthening of the tidal current. By this means is the volume of water conveyed alternately, in opposite directions, greatly increased, and the diminutive creek converted into a powerful stream."

When we see, on the one hand, a community laboring for a century to improve a navigable channel, persistently employing tidal currents as the chief agent therein, expending great sums in works designed to strengthen and give efficacy to these currents; and, on the other hand, find people recommending the expenditure of vast sums in works designed to exclude the tides from a navigable channel, we are led to think that one or other of these methods must rest upon an unsound principle. If we are to judge from results that method is not the one upon the Clyde.

The mouths or entrances of this channel would be substantially in the condition of the estuaries of tidal rivers, and would in some degree be liable to the difficulties that belong to such estuaries. One of these difficulties is that the current being brought to rest, or nearly to rest, upon entering the sea, deposits the material which it has abraded from the bottom and sides of its channel, creating the bars and shoals so common at the mouths of rivers. There is, of course, no reason to apprehend that this action would take place upon anything like the scale of magnitude observable in great rivers. From the short length of the channel comparatively little material would be taken up by the current. To whatever extent it did occur, however, it would require to be dealt with by the methods usually employed in such cases, among which it must be conceded that schemes involving the use of locks have met with but slight favor during the present century. The methods that have met with the most signal success have consisted in increasing the abrasive action of the current, sometime narrowing the channel and throwing the current in greater volume and velocity upon the bars by piers, sometimes by harrowing or raking the bar when the effluent current is strongest.

Messrs. Humphreys and Abbott* say in reference to the mouths of the Mississippi: "The development of laws which govern the formation of the bars has removed all uncertainty as to the principles which shall guide an attempt to deepen the channels over them. The erosive or excavating power of the current must be increased relatively to the depositing action. This may be done either by

* Report on the Physics and Hydraulics of the Miss. River, p. 255.

increasing the absolute velocity of the current over the bar, or by artificially aiding its action. To the first class of works belong jetties and the closing of lateral outlets. To the latter, stirring up the bottom by suitable machinery, blasting, dragging the material seaward, and dredging by buckets. These plans are all correct in theory, and the selection from them should be governed by economical considerations."

Movable jetties,* so constructed as to admit of being floated to any required position and removed on the approach of storms, have been used in some French harbors, particularly in the harbor of Dunkirk with very favorable results.

In 1858, a technical congress† assembled in Paris, composed of delegates from seven of the European states, to decide upon the best means of improving the mouths of the Danube. Two projects were brought before the convention. The first proposed to cut a ship canal from one of the main passes of the Delta, closing its upper entrance by a lock, and prolonging it by stone embankments until sufficient depth of water was reached. The second proposed to prolong the channel of the pass selected for improvement by parallel piers, directing the current with greater force upon the shoals. The first scheme, it will be noticed, proceeded upon the principle adopted by the advisory council upon the Cape Cod Ship Canal, the principle of excluding the current. The second upon the principle of giving full play to the current and taking all possible advantage of its abrasive action. Long journeys were performed by members of the convention in order to satisfy themselves by an inspection of existing works, as to which principle was best entitled to preference. The second method was adopted. ‡The works were commenced under the direction of Sir John Hartley, in 1858, at the Sulina mouth of the Danube, which at that time was not navigable for vessels drawing over 9 feet of water. Two piers were constructed, one 3,000 the other 4,631 feet long at a cost of $50 per linear foot. In 1861, this channel was navigable for vessels drawing 16 feet.

* Hagen, See-ufer und Hafen-Bau, Vol. III., page 80. Also Belidor. Architecture Hydraulique, Liv. III., chap. iii., sect. 3.

† Rapport de la Commission Technique Internationale convoque à Paris pour l'examen des questions relatives à l'amelioration des bouchs du Danube. Paris, 1858.

‡ Chief Engineer and Architect's Journal, 1862, page 115.

We all remember how fruitless were the attempts made to close the port of Charleston during the rebellion by sinking vessels loaded with stone in the principal channels. The current was checked in its usual channels only to be thrown with increased vigor upon the adjacent ground, and soon excavated new channels as deep as the former. A shallow depth, in soft material, is incompatible with a strong current.

The easterly entrance to this channel would be exposed to another cause of obstruction, viz: material borne along the shore by the action of the waves. This is a danger to which the entrances of many harbors are exposed, and would not, in this case, require any deviation from the methods ordinarily employed. The remedy lies not in the construction of locks or artificial harbors, but in giving a proper direction to the effluent current, and, perhaps, in the construction of groins along the beach to intercept the supply of travelling material.*

The Suez Canal would seem to deserve mention here, being constructed without locks. The precedent, however, is not conclusive, as the mean difference of level between the basins connected by it is only two feet. The Red Sea† is liable to fluctuations of 6·5 feet at spring tides, and 10 feet through the action of high winds. These heads, however, distribute themselves through a long stretch of the canal, and do not create currents comparable to those that might be expected in the C. C. Channel. These currents, however, are regarded as a very favorable circumstance with reference to the preservation of a sufficient depth at the Suez entrance, and the almost total lack of any such scouring agency at the northerly entrance has, in all discussions relative to this enterprise, been regarded as its most discouraging feature. This was one of Robert Stephenson's chief objections to the work, and this is what necessitates the immense piers, now over a mile in length and proposed to be extended to a length of four miles, at this extremity of the canal.

It may be said that the difference in cost between a closed canal and a free channel is apparent rather than real, since the artificial harbor, which forms the chief item in the cost of the former, might be dispensed with. I answer that an artificial harbor is the indis-

* As an example of the usual practice in such cases, see Discussions and Reports of Engineers upon the Harbor of Harurch Eng. Brit. Sess. Papers, 1861, v. 38, 1862, v. 34.

† Hagen, Wasserbaukunst See-ufer und Hafen-Bau. Vol. IV., page 75.

pensable accompaniment of a closed canal. In no other way can an entrance from an exposed coast be kept open, unless it is traversed by powerful currents. The approaches to a lock, on a sandy coast exposed to violent waves would fill up during a single storm. Dredges, from the nature of the case, cannot be effectively employed in such exposed localities, and no sluicing consistent with the maintenance of the canal surface at the level of high tide would be effective against such titanic agencies. The fatal decision to employ locks carries with it the inevitable necessity for a closed harbor. Give, however, the freest and fullest admission to the tides, and this necessity vanishes. So far as a harbor is necessary for the shelter of vessels, that can be obtained by running into the channel. So far as it is necessary to prevent the shoaling of the approaches, you establish a remedial force equal in activity to the destructive power of the waves, and which only needs suitable direction and control to enable it effectively to guard the entrance.

The learned and eminent gentlemen composing the advisory council upon the C. C. Ship Canal, in a former report, addressed to the city government of Boston * dwelt with great force and clearness upon the efficiency of tidal currents in maintaining a suitable depth in the channels of the harbor. Had there existed a natural channel across Cape Cod, and had they been desired to suggest suitable methods of improving and deepening it, I cannot think that they would so far have defied the most instructive precedents of modern engineering as to advise the exclusion of the tides. The problem, however, being the creation of an artificial channel instead of the improvement of a natural one, they were led by analogy rather than by investigation to recommend the use of locks.

The preceding hasty and imperfect sketch of this subject appears to me to warrant the following conclusions:

1. That the two modes of executing this work, the one by a closed canal, the other by a free channel, are founded respectively upon two radically diverse principles, of which the latter has received, by far, the more extended and successful application in the practice of modern engineers.

2. That while a free channel might not permanently maintain, in all parts, a sufficient depth, if abandoned entirely to the operation of natural agencies, yet, by establishing a suitable working force under judicious direction, to control the current, to protect the

* Boston City Doc., No. 12, 1861.

shores where abrasion was too rapid, to quicken the current where deposits occurred, to remove such deposits by dredging where less expensive means availed not, to repress, in a word, the mischievous and aid the conservative tendencies of the current—a suitable depth might, with a moderate annual expenditure, be maintained.

3. That with a free channel, no harbor, properly so-called, would be necessary.

Allowing two million dollars for excavation, one million for piers, groins, &c., and the interest of two millions for maintenance, the cost of the free channel would still be not more than half that of a closed canal with its necessary appurtenances.

THE KEOKUK AND HAMILTON BRIDGE OVER THE MISSISSIPPI RIVER AT KEOKUK, IOWA.

Statement of the Public Test of the Structure.

This bridge was tested May 18th, 1871, for Mr. J. Edgar Thomson, President of the Pennsylvania R. R. Co. The tests were made under the direction of Mr. Henry Pettit, Civil Engineer Construction Department Pennsylvania R. R., and all facilities for making them satifactory were kindly furnished by Mr. Geo. S. Smith, the Engineer of the Bridge, resident at Keokuk, who has had charge of the work at the bridge site from its commencement to its successful completion.

The designs for the superstructure were furnished by Mr. J. H. Linville, C. E., the drawings being carefully worked up under the direction of Mr. M. Benner at Pittsburgh. The superstructure was made and erected by the Keystone Bridge Co., of Pittsburgh.

Commencing at the west or Keokuk end of the bridge, the spans are located as follows: Pivot span, total length of one truss, centre to centre of end posts, 376′ 5″; opening under each arm of 160 feet measured on the square; 2 spans, 253′ 6″; 8 spans varying in length from 148′ $4\frac{3}{16}$″ to 161′ 7″; total length backwall to backwall on bridge seats, 2,192 feet. It is a through bridge built on a skew of 17° 15′, with a distance between the two trusses of 21′ 6″. It carries a single line of railway track and two tramways for local traffic, the track being placed in the centre between the tramways. On each side of the bridge, outside of the trusses, are foot-

walks 5 feet wide protected by light and substantial iron lattice railings.

When making the tests the level and rod were in charge of Mr. E. H. Worrall, Engineer of the Section Work, and Major A. H. Burnham, U. S. A., Engineer in local charge of the Des Moines Rapids Improvements of the Mississippi River near Keokuk.

The load used in making the tests was a train made up of five engines from the Des Moines Valley Railway, with their tanks and boxes full.

The following table shows the composition of this train.

Engines.	Total Length Engine and Tender.	Weight of Tender.	Weight of Engine.	Total Weight.
No. 1	39 feet.	16 tons.	26 tons.	44 tons.
19	41′ 7″	20 "	31½ "	51½ "
22	42′ 5″	20 "	31½ "	51½ "
20	41′ 7″	20 "	31½ "	51½ "
3	40′ 5″	18 "	27 "	45 "
Totals	205′ 0″			243½ tons.

This load was placed so as to cover one-quarter of the span, when the deflections of the span were taken at the centre and quarter distances. The span was then loaded one-half of its length, then three quarters, and finally its entire length. The deflections being taken each time at the same three points. Afterwards the permanent set was observed. All the lengths of spans given are the distances from centre to centre of the end posts.

Pivot span (the largest yet constructed.)

Total length of one truss..... 376 ft. 5 inches.
Arched upper chord. Depth of truss over drum..... 35 ft.
" " at ends..... 27 ft. 9 inches.

Load of 95·5 tons on the east half of the east arm = 1·07 tons per foot lineal.

East arm of span.

Deflection of the east half ..... ⅛ inches.
Deflection at the centre..... 1⅛ "
Deflection of the west half..... $\frac{5}{32}$ "

West arm of span.

Deflection of the east half ..... $\frac{3}{32}$ inches.
Rise of the centre ..... $\frac{3}{32}$ "
Rise of the west half ..... $\frac{3}{64}$ "

Load of 178·5 tons, covering entirely the east arm = 1 ton per foot lineal.

East arm of span.

Deflection of the east half ..... $\frac{23}{32}$ inch.
Deflection at the centre ..... $\frac{1}{32}$ "
Deflection of the west half ..... $\frac{23}{32}$ "

West arm of span.

Rise of the east half ..... $\frac{1}{32}$ inch.
Rise at the centre ..... $\frac{1}{8}$ "
Rise of the west half ..... $\frac{3}{64}$ "
Strain of compression at centre of upper chord of east arm ... 6752 lbs. per sq. in.
Strain of tension at centre of lower chord of east arm ..... 7063 " " "

Load of 103 tons on east arm and 96·5 tons on the west arm = ·56 tons per foot lineal.

East arm—

Deflection at the centre ..... $\frac{21}{32}$ inch.

West arm—

Deflection at the centre ..... $1\frac{3}{32}$ inch.

Permanent set after all load was removed.

East arm—

East half ..... $\frac{1}{10}$ inch.
Centre ..... $\frac{1}{37}$ "
West half (next the drum) ..... $\frac{1}{10}$ "

West arm—

East half (next the drum) ..... $\frac{5}{32}$ inch.
Centre ..... $\frac{1}{80}$ "
West half ..... $\frac{1}{27}$ "

Time of turning the pivot the entire opening of 72¼°.

With the engine ..... 2 minutes.
With six men ..... 2 minutes 30 seconds.

Span No. 3.

Length 253′ 6″. Height of truss 27 feet.

Ratio of height to length = 1 to 9·388. Load of 68 tons on the east quarter = 1·07 tons per foot lineal.

Deflection of the east half ..... $\frac{3}{32}$ inch.
Deflection at the centre ..... $\frac{1}{8}$ "
Deflection of the west half ..... $\frac{1}{27}$ "

Load of 147 tons on the east half of span = 1·16 tons per foot lineal.

Deflection of the east half	$1\frac{3}{16}$ inch.
Deflection at the centre	$1\frac{3}{16}$ "
Deflection of the west half	$1\frac{1}{16}$ "

Load of 198·5 tons on the east three-quarters of span = 1·04 tons per foot lineal.

Deflection of the east half	$\frac{31}{32}$ inch.
Deflection at the centre	$1\frac{1}{32}$ "
Deflection at the west half	$\frac{13}{32}$ "

Spread of lower chord measured at the roller box = $\frac{3}{16}$".

Load over the entire span of 243·5 tons = ·96 tons per foot lineal.

Deflection of the east half	$1\frac{5}{32}$ inches.
Deflection at the centre	$1\frac{11}{16}$ "
Deflection of the west half	$1\frac{1}{4}$ "

Spread of the lower chord measured at the roller box $\frac{1}{4}$".

Strain at centre of upper chord, compression = 8962 lbs. per square inch.

Strain at centre of lower chord, tension = 9251 lbs. per square inch.

Span No. 2.

Length 253′ 6″. Height of truss, 27 feet.

Load of 243·5 tons over the centre span = ·96 tons per foot lineal.

Deflection at the centre of span = $1\frac{3}{4}$ inches.

Permanent set after load was removed = $\frac{3}{64}$ inches.

Span No. 4.

Length 159 feet $9\frac{1}{8}$ inches. Height of truss 21 feet.

Ratio of height to length 1 to 7·6·

Load of 44 tons on the east quarter = 1·1 tons per foot lineal.

Deflection of east half	$\frac{9}{32}$ inch.
Deflection at the centre	$\frac{5}{16}$ "
Deflection of the west half	$\frac{1}{32}$ "

Load of 95·5 tons on the east half = 1·19 tons per foot lineal.

Deflection of the east half	$\frac{7}{16}$ inch.
Deflection at the centre	$\frac{13}{32}$ "
Deflection of the west half	$\frac{1}{8}$ "

Load of 147 tons on the east three-quarters of span = 1·22 tons per foot lineal.

Deflection of the east half	$\frac{5}{8}$ inch.
Deflection at the centre	1 "
Deflection of the west half	$1\frac{3}{16}$ "

Lood of 153 tons over the entire span = ·905 tons per foot lineal.

Deflection of the east half	$\frac{23}{32}$ inches.
Deflection at the centre	$1\frac{5}{32}$ "
Deflection of the west half	$1\frac{7}{16}$ "

Permanent set after load was removed. At the centre of span = $\frac{1}{4}$ inch.

RAILROAD BRIDGE OVER THE CUMBERLAND RIVER AT NASHVILLE, TENN.

By F. W. Vaughan, C. E.

This bridge carries the traffic of the Louisville and Nashville, and Edgefield and Kentucky Railroads over the Cumberland River at Nashville, Tennessee, and as a link in the chain of direct railroad connection with the South, is second in commercial importance to no bridge south of the Ohio River; to the engineer it is of particular interest as the first example of the Iron Triangular Truss constructed in this country.

Before giving a detailed description of the existing superstructure, a few facts concerning the sub-structure, as well as the preceding superstructures will be of interest.

The masonry was built in 1858–9, and on it was erected a McCallum superstructure, the successful construction and operation of which was at the time considered a great triumph in bridge building. This structure did good service till February, 1862, when, upon the approach of the Federal troops, the Confederates loaded it with guns and other munitions of war, and destroyed it by fire; the slight damage thus done to the masonry was repaired and a superstructure promptly erected on the Howe plan by the U. S. Government, the railroad Company subsequently paying for the same.

This structure sustained the heavy traffic incident to the war satisfactorily, till the fall of 1866, when it began to show decay and weakness; as it was impracticable to erect another superstructure before the following season, iron clamps were put on the lower chords, and the spans otherwise strengthened, so that they did service till replaced by the existing structure in the summer of 1867.

Arrangement of Spans.—The total length of bridge is 700 feet, and is divided into two fixed spans of 210 feet each from centre to centre of piers, and a draw span 280 feet long over all, with clear openings of 120 feet, the draw being between the fixed spans. (See general view, Fig. 1, Plate I.) The base of rail is about 80 feet above the rock bed of river, and the clear space above high water is 7 feet.

Masonry.—This is of limestone laid in cement, and consists of five piers, (including two rest piers for draw at right angles to line

of bridge), and two abutments; the aggregate quantity is 6,300 cubic yards. The Western abutment and all of the piers have for their foundations the solid rock, while the Eastern abutment rests on an artificial foundation of concrete over-piling. The piers were put in by coffer dams without trouble, the minimum summer depth of water being only twelve feet.

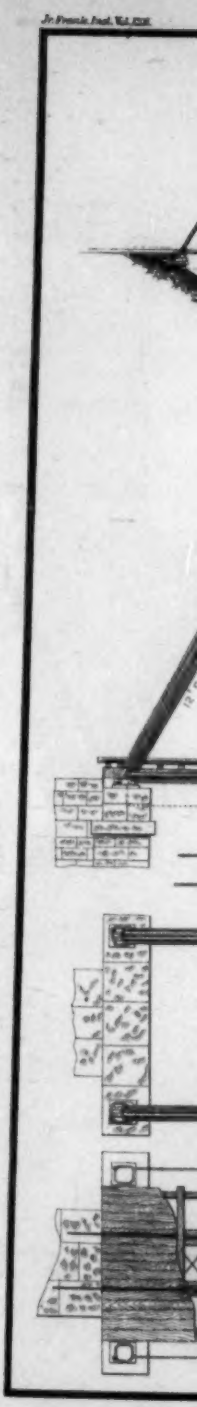
The regular piers are 10′×25′ under the coping, and have a batter of one-half inch per foot. The rest piers are 3′×25′ under the coping, and are strengthened by massive starlings. The round pier is 30 feet diameter, and has a slight batter.

Existing Superstructure.—This consists, as already stated, of two fixed spans, and a draw; it is on the triangular plan, and entirely of iron. The iron work was commenced in the spring and the bridge raised during the season of low water in the summer of 1867. The operation of raising was attended with considerable difficulty, on account of the position of the bridge, forming as it were a part of the yard in which trains are made up at Nashville. The workmen not only had to guard against the delay of regular trains (of which there were many), but offer as little obstruction to the regular switching of the yard as possible, very little of which could be done without running on or over the bridge. The removal of the old Howe trusses, and the erection of the present ones, was accomplished without delaying any of the regular trains. The draw was raised in the line of the bridge, there being no boats with which the trestle would interfere at this season.

The work for the fixed spans was done in the shops of the Louisville and Nashville Railroad at Louisville, and for the draw by the Louisville Bridge and Iron Company.

Fixed Spans.—These are 210 feet from centre to centre of piers. The trusses are placed 16′ 6″ apart between centres, have a depth of 25′ 6″, and a length of 204′ 9′ from pier to pier. Figure 2 Plate I is a side view of half one of these spans, Fig. 3 an end view, Fig. 4 plan of lower chord, Fig. 5 a partial view of top frame, and Fig. 6 a partial view of bottom frame.

The top chords are cast iron tubes, octagonal on the outside and circular on the inside, with a uniform external diameter of 12 inches; the thickness of metal varies in the different panels, being reduced in proportion to the strain from middle to end of span. The cords are cast in sections, (with brace seats attached), the length of the long panel (29′ 3″), joined by tenons and sockets,



CUMBERLAND RIVER BRIDGE L&N R.R.

Nashville Tenn

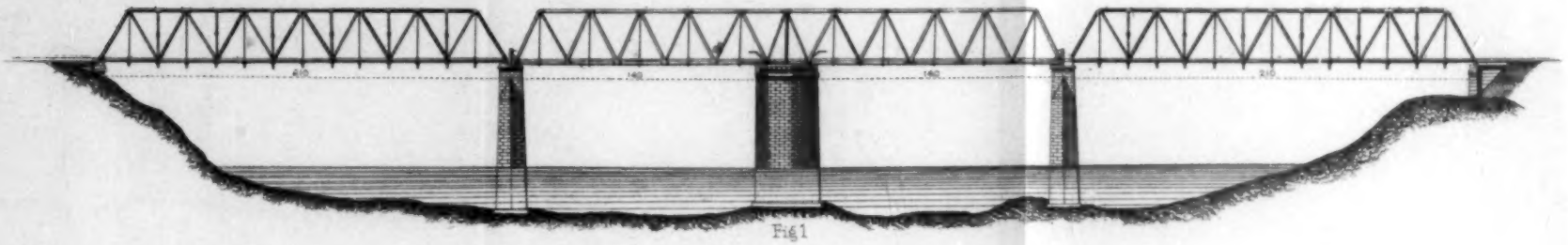
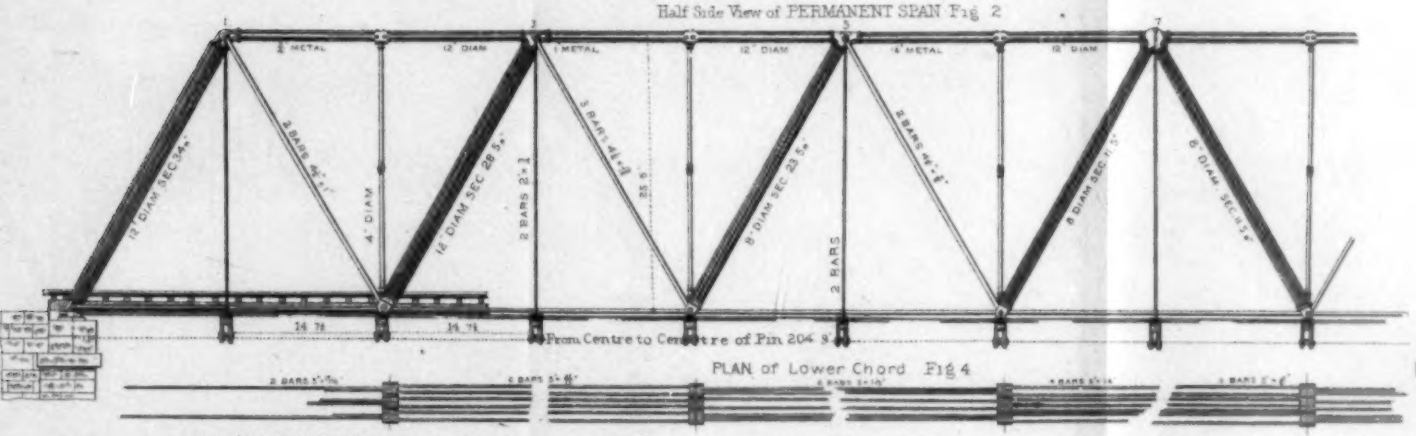


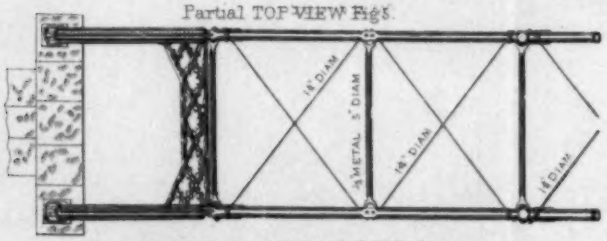
Fig 1

Half Side View of PERMANENT SPAN Fig 2

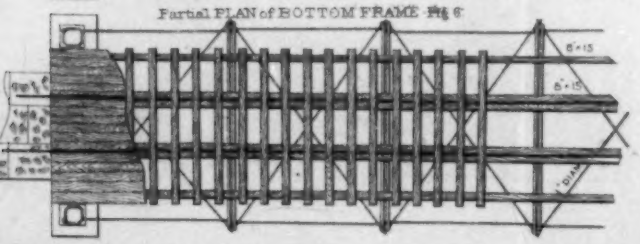


PLAN of Lower Chord Fig 4

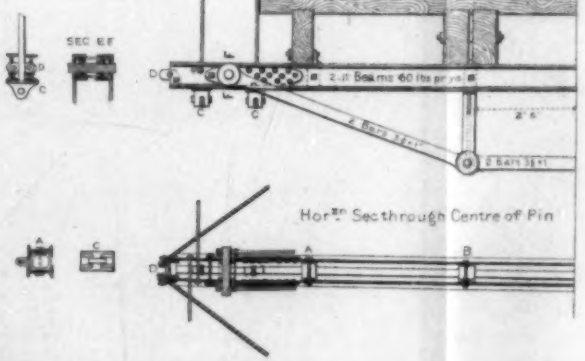
Partial TOP VIEW Fig 5.

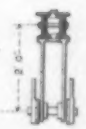


Partial PLAN of BOTTOM FRAME Fig 6



FLOOR BEAM Fig 8





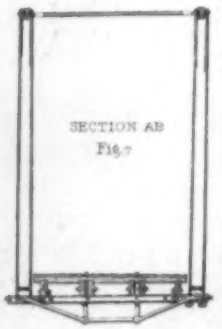


Figure 1
Figure 4
Figs 2,3,5,6,7
Figure 8

Jno. W. Hodgson Lith. Phila.

(turned and bored to fit), the abutting faces and brace seats are carefully faced off, and the pin holes drilled to fit the pins. The quality of metal in each casting was tested by pouring from the ladle containing the mixture for this casting, two test bars five feet long, and one inch square, each when placed upon knife edges four feet six inches apart was required to sustain 525 lbs. applied at its centre, this degree of strength having been shown by various experiments to indicate a first-class mixture of cast iron ; two bars were always made to ensure a test, it sometimes happening that one would have a flaw. One sound test-bar breaking with less than the proscribed weight, would ensure the rejection of the casting from the same ladle. This, however, did not occur—the bars breaking on an average with 570 lbs., and one with as high as 650 pounds.

Mr. Fairbairn, in his work on cast and wrought iron, page 72, records the results of testing forty-one different kinds of English irons, in bars the same as here used. The highest test thus obtained was 567 lbs., and the lowest 353 lbs. Before finishing these chord pieces small holes were drilled at the two points where the core was most likely to rise, and the metal measured to ascertain if any inequality of thickness existed, they were also carefully examined and hammered to detect "cold shuts," "air blows," or other defects. The struts connecting the top chords and forming part of the top system of lateral bracing, the brace shoes, pier bearings, floor beam posts, &c., are also of cast iron, and of the same quality as the chords.

The braces are wrought iron Phœnix columns, sections of which are shown by Fig. 2. They were well painted on the inside before erection.

The vertical posts are wrought iron tubes $4\frac{1}{2}''$ diameter each post is spliced at its middle by a cast iron swivel with a right and left hand thread, which also serves as an adjustment for the length of the post.

The wrought iron for the lower chords, ties, suspension bars, diagonal rods, pins, &c., is of the best quality, having an ultimate strength of 60,000 lbs. per square inch. The heads are welded to the bars, and the pin holes drilled to closely fit the pins, which are carefully turned. The bars were all tested with a strain of 20,000 lbs. per square inch, (nearly twice the maximum working strain). The spans rest at the piers on planed cast iron plates, on which they slide when effected by changes of temperature. Fig. 7 shows the arrangement of roadway supported by transverse iron floor beams, shown in detail by Figures 8 and 9.

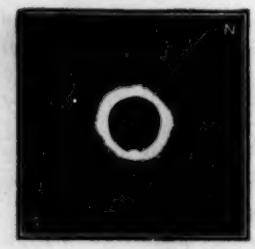
(To be continued.)

Mechanics, Physics, and Chemistry.

PHOTOGRAPHING THE CORONA.

By Prof. EDWARD C. PICKERING.

THE difficulty in photographing the corona visible around the sun during a total eclipse, is mainly due to its small actinic power. To remedy this we must increase the light in our camera as much as possible, and therefore when attached to Prof. Morton's Eclipse Party, in August, 1869, I proposed that a common portrait camera should be used. As with such an instrument we can obtain an impression of objects in a comparatively dark room in a few seconds, it seemed probable that in two or three minutes so bright a body as the corona would produce a very distinct impression, even of its more remote portions. We found in Mt. Pleasant where we were stationed, two photographers, Messrs. Hoover Bros., who undertook to give this plan a trial, and as a result they obtained a photograph, which is represented in the accompanying figure to double its original size. I believe the exposure lasted during nearly the whole period of totality, the apparent motion of the sun being avoided by following it with the camera. The aperture of the lens being much greater compared with its focal length than that of any telescope, so much light is concentrated that an impression of a large part of the corona is obtained, giving one of the best photographs of this body yet taken.



A comparison with the view taken by Mr. Whipple in Shelbyville shows many points of resemblance, and greatly strengthens any conclusions based on either. It also proves that the structure common to both is solar, or at least not due to any local irregularities in our own atmosphere. The indentation in the moon's limb marks the position of the large protuberance then visible, and we readily perceive the bases of the five points or streamers which were noticed at the same time. The line N. S. gives the direction of the sun's polar axis and shows the increased height of the corona at its equator, and the corresponding diminution at its poles. The experiment is so easily tried by any photographer on the line of totality as to encourage the hope that in future eclipses, views may be taken from a great many points with the largest portrait cameras, and thus eliminating all local effects, show with certainty how much of the corona is really solar.

Massachusetts Institution of Technology, May 15th, 1871.

PENNSYLVANIA'S ANCIENT SEA.

Lecture delivered before the Franklin Institute, Thursday evening, Jan. 5, 1871.

By Prof. Leeds.

In a preceding lecture, upon Pennsylvania's Foundation Stones, I have sketched out the anatomy of the North American Continent. We have seen that there is a broad area, which includes almost the whole of New England, northern New Jersey, south-eastern Pennsylvania, the middle of Maryland and Virginia, and stretches thence southward to the centre of Georgia and Alabama, that is made up of gneissoid rocks. It has served, in the structural growth of the continent, as a vertebral column, a backbone to which the later formations have attached themselves in the process of development of an organic whole, such as the continent presents itself to us at the present day. I say organic, because no other word appears adequately to express the mutual dependence and co-operation of its various parts. For has it not a most highly complicated fluid circulation? Are not vast bodies of water daily lifted from the ocean to its table lands and mountain tops, and then poured through a million capillaries and arteries, so as to refresh the plains with gladness and fertility? Its endless modifications of surface, its countless valleys and hills divide the trade winds into myriad currents and counter-currents, and originate an ærial circulation so perfect that miasm and pestilence are well nigh unknown. Here are boundless stores of coal and iron, there salt and oil, copper is found in a third place, in such huge masses that the miners are at a loss how to work it, while the slopes of the Sierra Nevada have revealed at last the long sought for El Dorado. No part of the continent is complete in itself, but taken in conjunction with all the rest, it makes a geological unit.

From this backbone there extend two arms, one lifted to the north-east and stretching from northern New York to the coast of Labrador, the other much longer, reaching to the shores of the Arctic Ocean.

This backbone and these two arms, as we have seen previously, have survived from a world which perished beneath the sea prior to the coming of animals and plants upon the earth. They survived to perform a most important office, for they form the skeleton upon

which the North American Continent, such as exists at present, is built.

To the westward extended a vast tract of shallow seas, with here and there, as in Wisconsin, Missouri and Arkansas, a small barren island. Great banks and shoals, not unlike those which at present underlie the fishing grounds off the coasts of Newfoundland, existed where now stands Cincinnati, and in many places besides. As now the beaches of New Jersey slope downward with such a gentle declivity that it is not until we have gone eighty or a hundred miles from the shore that we make the grand plunge and reach the terrible abyss of mid-ocean, so then the eastern shores of this narrow V-shaped continent probably were quite shallow over eastern New Jersey, Delaware, Maryland, Virginia, North and South Carolina, Georgia and Florida.

If you will have the patience to follow me, we shall endeavor to travel together in company along the western shores of this continent, and trace out its windings and bays and gulfs. We shall stop to consider the furrows and marks of ancient tides and waves and storms, while here and there the traces of seaweeds and stranded crab or shell will for a moment delay our steps.

The labors of the many eminent men who have spent months of pedestrian travel and years of profound thought in determining this coast-line teach us that it approached nearest to the present site of this city at a point on the Philadelphia and Westchester Railroad, a few miles to the eastward of Media. It then followed a south-westerly direction through Chadd's Ford, Kennett Square and New London, leaving the State a few miles on this side of the crossing of the Susquehanna into Maryland at the State line. From this point it extended through western Maryland, Virginia, North Carolina and Georgia, almost if not quite to the middle of Alabama. Tracing it to the north-eastward, from the point on the Westchester Railroad where we first set foot upon this ancient shore, we follow it round a long cape which jutted out into the sea at Castle Rock, Marshalton and Locust Grove, and then crossing the present bed of the Schuylkill not far from Conshohocken, extended on until it passed out of the State at Trenton. To the westward of this continental seabeach were a number of long islands, some broad, some narrow, which formed a succession of sounds lying one beyond the other, very much of the same kind as we find along the coast of North Carolina at the present day. Crossing the northern angle of

New Jersey, it followed the Hudson to Lake Champlain, and then swept around to the south-westward, forming a great gulf along the valley of St. Lawrence, and enclosing the whole of northern New York in a great peninsula joining on to the mainland at the eastern angle of Lake Ontario. From this point it followed a line running not far from the northern boundaries of Canada to Lake Huron, and thence along the southern shore of Lake Superior, through Wisconsin, Iowa and Minnesota, north-westward to the Rocky Mountains.

Although nothing green or living could have been seen by any explorer upon this desert shore, yet it was not without some diversity of scenery. Along the Pennsylvania shore were low hills and broad valleys, with here and there a creek or river running downward to the sea. Inland from the Canadian beach were higher ranges, acclivities which in many cases probably exceeded a thousand feet in height. These primeval rivers carried down with them fragments of feldspathic and talcose rock, and oftentimes were turbid with soil washed inward from their banks. Layer after layer of these materials were laid down upon the ancient shore, and hardened by heat from within and from without, consolidated by the weight of later rocks deposited upon them, gradually became laminated stone. Their strata are never parallel to the underlying rocks, but tilt against them at some angle, the degree of inclination greatly varying. In Pennsylvania so greatly have they been crumbled and folded, that everything living or organic which they may have contained has perished utterly. Even the thickness of these distorted beds is with great difficulty to be estimated. Probably, however, they did not fall far short of a quarter of a mile in depth.

A period of greater regularity and quiet appears to have followed the deposition of these earliest beds. It is marked by the presence almost everywhere along this coast line of more than two thousand miles in length, of deposits of fine white and yellowish sand. Though of sand, it is by no means a dead and trackless waste. On the contrary, if we could wander over this wide strand, we should find a myriad of marks and tracings which would engage our earnest study, and certain remains indeed so peculiar that no beach, however beautiful, could so richly repay a walk upon it. The waves that beat upon this beach have not died away and left no sign; the tides have registered themselves as unerringly and far more en-

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The labors of the many eminent men who have spent months of pedestrian travel and years of profound thought in determining this coast-line teach us that it approached nearest to the present site of this city at a point on the Philadelphia and Westchester Railroad, a few miles to the eastward of Media. It then followed a southwesterly direction through Chadd's Ford, Kennett Square and New London, leaving the State a few miles on this side of the crossing of the Susquehanna into Maryland at the State line. From this point it extended through western Maryland, Virginia, North Carolina and Georgia, almost if not quite to the middle of Alabama. Tracing it to the north-eastward, from the point on the Westchester Railroad where we first set foot upon this ancient shore, we follow it round a long cape which jutted out into the sea at Castle Rock, Marshalton and Locust Grove, and then crossing the present bed of the Schuylkill not far from Conshohocken, extended on until it passed out of the State at Trenton. To the westward of this continental seabeach were a number of long islands, some broad, some narrow, which formed a succession of sounds lying one beyond the other, very much of the same kind as we find along the coast of North Carolina at the present day. Crossing the northern angle of

New Jersey, it followed the Hudson to Lake Champlain, and then swept around to the south-westward, forming a great gulf along the valley of St. Lawrence, and enclosing the whole of northern New York in a great peninsula joining on to the mainland at the eastern angle of Lake Ontario. From this point it followed a line running not far from the northern boundaries of Canada to Lake Huron, and thence along the southern shore of Lake Superior, through Wisconsin, Iowa and Minnesota, north-westward to the Rocky Mountains.

Although nothing green or living could have been seen by any explorer upon this desert shore, yet it was not without some diversity of scenery. Along the Pennsylvania shore were low hills and broad valleys, with here and there a creek or river running downward to the sea. Inland from the Canadian beach were higher ranges, acclivities which in many cases probably exceeded a thousand feet in height. These primeval rivers carried down with them fragments of feldspathic and talcose rock, and oftentimes were turbid with soil washed inward from their banks. Layer after layer of these materials were laid down upon the ancient shore, and hardened by heat from within and from without, consolidated by the weight of later rocks deposited upon them, gradually became laminated stone. Their strata are never parallel to the underlying rocks, but tilt against them at some angle, the degree of inclination greatly varying. In Pennsylvania so greatly have they been crumbled and folded, that everything living or organic which they may have contained has perished utterly. Even the thickness of these distorted beds is with great difficulty to be estimated. Probably, however, they did not fall far short of a quarter of a mile in depth.

A period of greater regularity and quiet appears to have followed the deposition of these earliest beds. It is marked by the presence almost everywhere along this coast line of more than two thousand miles in length, of deposits of fine white and yellowish sand. Though of sand, it is by no means a dead and trackless waste. On the contrary, if we could wander over this wide strand, we should find a myriad of marks and tracings which would engage our earnest study, and certain remains indeed so peculiar that no beach, however beautiful, could so richly repay a walk upon it. The waves that beat upon this beach have not died away and left no sign; the tides have registered themselves as unerringly and far more en-

duringly than any tide-measurers which man's ingenuity has yet set up. We can follow the pathway of the storm and note the direction of the wind. Enough remains to tell us what kind of atmosphere and climate existed at that incredibly remote era. We do not imagine vain fancies when we picture to ourselves the rays of the sun piercing down through the cloud-laden sky and lighting up the sandy reaches of the primeval shore, and striking across slope and glen. Whatever doubt be entertained concerning the presence of life in the underlying strata, no one will question that upon these sandy beaches there flourished plants and animals, which drew from air and sun and water their strength and sustenance.

As we turn over some great slab of sandstone which once formed a part of this beach, we find its surface covered with delicate curving and recurring lines, interlacing one with another in the network of fantastic tracery. Is there nothing familiar to the experience of every one of us which may serve to explain the riddle? Many a time, perhaps, while idly sketching the fabric of sea-side reveries upon the ocean shore, we have followed the breakers as they ran out their long lines of creamy spray, each successive one lower than that which had gone before, until at last in one broad sheet they ran up the beach and marked their limits by a faint furrow and pencilling in the sand. When gentle breezes caught the retreating wave and tossed it into tiny ripples, they were mirrored in the yielding sand beneath, and when preserved by the hardening of the mould, they were recorded imperishably. Sometimes, too, we encounter upon the sandstone diverging lines of broken shell and pebble, which point to some obstacle that has hindered the down flow of the retreating wave, and caused it to drop a portion of the booty that it had snatched from a higher level. And often on the seaward side of such an obstacle, a wedge-shaped pit, where the rapid movement of the eddy which it formed prevented the deposition of the sand behind it. These rocks in many places are pierced through and through by a marine worm, called the *scolithus linearis*, which found a living just along the water's edge. Though its long, fleshy body has perished, yet its place has been subsequently filled in with sand, and so numerous and widespread are these worm-like cylinders of sand that their presence is in the highest degree characteristic of the time and circumstances which we are at present studying.

We follow a layer in these sandstones until it thins out to a knife-edge and then disappears. Above and below it are other layers

made up of sand coarser or finer, of pebbles great or small, sometimes laminated parallel, at other times obliquely to the surface, and here a few lines and there many inches in thickness. All these appearances point to a time when these sandstone slabs were sand, and were piled up by the ebb and flow of the tide, or spread out upon the beach by ocean currents. Not less indicative of an exposed shore are little hillocks of sand with their crests blown away, and other hillocks covering their tops, or sloping up against their sides from a different quarter—wind-guages, as it were, which serve to tell us of the direction and strength of the winds which blew some thousands of centuries ago. And if these failed us, there are not lacking other marks quite as full of significance; as, for example, little pits, sometimes scarcely to be perceived, looking as though made by a gentle rainfall pattering downward directly from above, and then again ploughed in to north, or south, or east, or west, according as the tempest raged from one or another quarter. Where the sand is mixed with clay or mud carried down to the sea from some creek or estuary, it has shrunk as it hardened on exposure to the sun, and has cracked into a thousand intersecting fissures. Subsequently these have been filled in with a softer or denser, a lighter-colored or darker material, and when allowed to decay under the action of the weather are traversed by furrows or cut up by hard ridges, like a honey-comb, as the case may be. At times, some of the little marine animals left their dwelling, on excursions for business and pleasure, and if the breezes which swept along the shore happened to be laden with sand, they filled up the foot-marks of the traveller, and recorded the story of his wanderings for our amusement and instruction.

But very little went on in these early times of which we have no hint or tidings. If some mean worm vanished, a grave at least was necessary for his burial, and the grave without its inhabitant has come down to us. If the sun was much obscured by fogs and clouds, we have the Trilobite with great staring eyes like horns to tell us that it was needful for such a big fellow to make the most of the light there was, to get his food and living by. No tide that ebbed or flowed for countless centuries passed away without leaving some rill or ripple-mark to preserve its memory to the remotest reach of time. Even the fickleness of the wind and its veerings to and fro are as patent to the observer upon the shores of this ancient sea, as to him who has looked to-day upon its constant shifts and whirls.

Will the countless volumes written upon papyrus, and parchment, and paper, graven in brass or cut in stone by the hand of man, be one-half so enduring?

This beach reveals to us the beginnings of vegetable life; plants of little interest to the botanist so far as their structure is concerned, or to the curiosity-seeker, so far as relates to their beauty—but to him who is intently watching the world's development, of the highest import. These plants were fucoids, not of the delicate forms and exquisite tints which insure them a welcome place in the albums of lady visitors to the sea shore, but looking more like leathern aprons. The tissue of the sea weed has never been found in a state of preservation. But sometimes the fact of its existence is made known to us by the thin seams of mineral coal into which the stems and aprons of these sea weeds by heat and pressure have been converted. Few as are the forms of these marine plants which have been preserved to us, and homely as was their appearance, yet we cannot overestimate their importance. To them, the animals which appeared at a later period of the world's development were indebted for the material of nerve and tube and muscle. It was only the stuff of shell or skeleton which the animal could elaborate directly from the waters of the sea. And so prolific are these sandy beaches in relics of animal as compared with plant life, that two ideas suggest themselves as of great probable truth, and worthy of careful testing by a scrutiny of these sandstone rocks. The first is that a vast number of minute vegetables, which served to nourish animal life have hitherto escaped detection, or have been so pulverised and broken that they can never be distinguished. We know of the existence of similar plant-growths occurring in rocks of subsequent origin, and although of such microscopic dimensions as that millions of their flinty shells compacted together do not make up the bulk of a cubic inch, yet huge masses of rock are built entirely out of them. These infusoriæ were builders in flint—withdrawing silex from the water and storing it up in their stony skeletons. Their co-laborers the corals preferred limestone as a building material, each tiny workman bequeathing the house he had built and in which he lived to the coral community at his death.

The second idea which has suggested itself in this connection is that the sea differed at that period very widely from its present composition, and was very much more charged with mineral matter than now. Our daily observation teaches us with what energy the air and frost

and sun, ice and moving water are operating upon the earth's crust at the present time. The decay of plants forces itself upon our attention from the fact that the beautiful shapes of leaf and flower and branch are quickly lost, and the vivid coloring of life is exchanged for the ugliness and blackness of death. Rocks are rotting surely and rapidly too. But their covering of soil, and the likeness of the decayed to the solid stone, hide their dissolution from the casual glance. The rain drop which falls from heaven is not the emblem of purity that we poetically imagine it to be. It has caught up in its descent impurities of many kinds. It is laden with nitrogen and its compounds, with microscopic germs capable of producing and sustaining life, and with carbonic acid. As soon as the latter comes in contact with gneiss or schist or granite, it is busy at its work of corrosion. Salts of soda and potash and lime, of iron and magnesia, are being extracted from their storehouses in the hills, and fed out to the world in countless tons yearly, just as the requirements of its organic growth demand. An elevation of the earth's temperature by a few degrees would heighten the solvent power of the water and increase the manufacture of every salt enormously, and without precipitation from the sea or the number of rock-forming plants and corals, increased in the same proportion, would make of the ocean another Dead Sea.

(To be continued.)

THE SUN.

A Course of Five Lectures, before the Peabody Institute of Baltimore.

By Dr. B. A. Gould.

(Continued from Vol. LXI, page 201.)

In the general programme laid out for these lectures, the present one was assigned for the consideration of physical investigations into the constitution of the sun, while the second treated of the appearance manifest to the observer. Although the two subjects appear sufficiently distinct, yet the boundary line between them is shadowy and undefined, inasmuch as the greater portion of our physical researches must necessarily be made by means of direct observation of the sun's aspect. Therefore I will make no apology for beginning my discourse this evening with a few words

more regarding the spots in certain respects which bear closely upon questions of solar physics, although it might have been more appropriate to discuss them in my last lecture, had my other remarks been less extended.

I have said that the spots are undergoing continual changes of form and aspect. The amount of these changes and the magnitude of the actual motions which they seem to imply is truly marvelous. One observer* estimates the velocity of the flashes across the penumbra, by which bridges of light are formed, as 125,000 miles in a second; and cases are by no means rare in which the dimensions of a spot have been seen to change by a couple of thousand miles in a single hour. The photographs which Prof. Mayer obtained in August, 1869, and which I have already shown you, exhibit different views of the same spot, taken before and after the total eclipse. The interval between the two was less than two hours, during which time the nucleus had widened by 1,800 miles in one direction, and narrowed by 2,350 miles in another, while the transformations perceptible in the group immediately north of the large spot indicated an equally intense activity there. I do not myself believe that any actual transference of matter occurred with the rapidity which appearances would indicate, and as for the projection of the luminous particles with such a velocity as 125,000 miles a second, or even the hundredth part of this, it is highly improbable; but that the *appearance* of such motion has been exhibited, cannot be doubted.

The natural history of the solor spots is full of interest; the phenomena of their first outbreak, their development, and their dissolution have been described in great detail by many observers; and the published descriptions of the curious processes there seen in action would fill volumes. There seems also to be more than one kind of spot, some being deep and others apparently superficial,—some with penumbra, and others without it; but our limits forbid me to enter into any detail in their description, other than a brief summary of the general facts. Originating as black points, (like one of those, of which so many exist at all times upon all parts of the sun,) or formed by the aggregation of several of these, they increase rapidly in size, soon developing a penumbra, which increases with equal rapidity, until, generally in the course of a single day, they arrive at the full maturity of their dimensions, and

*Peters.—Proc. Amer. Assoc. Adv. Science. 1855. p. 94.

thereafter continue their existence, though with largely fluctuating outlines, during a period of uncertain length, usually from twenty to forty days, and sometimes even for three or four months. For the first few days they usually exhibit a tolerably roundish form, with regular and uniform penumbra. Then the irregular indentation of the margin, always visible with a good telescope, but generally quite slight at first, become deeper and deeper, until at last they actually divide it into segments; the boundary of the nucleus becomes similarly affected, and a period arrives at which the formation of bridges begins, which cross the nucleus and subdivide the spot into two or more parts; these in their turn being again divided into yet smaller ones which gradually contract and disappear. During this process of destruction whole tracts of penumbra are sometimes seen to break away from the rest and gradually fade from sight in the dark chasm of the nucleus; and so, too, portions of the photosphere or glowing outer surface have been seen to cave in, as it were, and, traversing the penumbra, to lose their brilliancy by degrees and to become extinguished in the central cavity. Even isolated granules have been seen to detach themselves from the edge and follow the same course; and careful scrutiny has shown that the granules of the photosphere all around the margin point inward; that in the bridges all the granules are parallel, extending lengthwise like straws closely packed together, and that the decrease of brilliancy in the penumbral or photospheric matter, as it disappears in the yawning void, is due to a diminution both in the size and the brightness of the individual granules. These observations are of great importance, for they suggest a vaporization as they disappear, as well as some strong polar attraction, whether electrical, chemical, or otherwise, which leads to the formation of bridges as well as to the radiating arrangement of the granules around the spot.

Many interesting observations have been made regarding the mutual relations of the various spots in a group, the order of their formation and disappearance, and their mode of developement. So, too, have curious facts been gathered concerning the tendency of spots to rotate around their centre, and the various tints observable in their nuclei. But all this must be passed over, for our subject is large, and our limits are narrow.

The great fact, to which I have more than once alluded, that the sun is practically our only source of earthly power and energy,

gives a peculiar interest to the question whether his brilliancy or thermal energy are undergoing any perceptible diminution. That they are diminishing, we must assume on general principles, inasmuch as we know to what an inconceivable extent he is radiating force in the various forms of heat, light and chemical power; and force, once emitted from a source of such superior energy, is not returned to it again; while a new creation of force by natural agencies is just as impossible as a new creation of matter. But whether any diminution of radiant energy in consequence of the enormous expenditure is perceptible by our means of investigation is a most natural and important question, and to this it must be answered that no appreciable decrease has been detected. Few observations available for the purpose have been bequeathed to us by the astronomers of former days; but from some careful observations* which the distinguished astronomer Olbers made in 1801 upon the brilliancy of Mars which depends of course upon reflected solar light. Prof. Seidel of Munich was able to prove† in 1859 that the solar light had not diminished in the interval to any measurable extent. It has been well said that had some of the old Greek metaphysicians once dipped a thermometer into the Ilisuss and recorded the date and temperature, it would have added a thousand fold more to our knowledge than all their speculations did. We can forgive them for this omission, if for no other reason than that they had no thermometer to dip; but had they even so much as recorded the average date of flowering of any common plants, we should be able to thank them for at least some materials whence we could obtain valuable geological and cosmological knowledge.

In 1845 our countryman, Prof. Henry, succeeded in discovering‡ that the spots radiate less heat than other portions of the sun's surface; Secchi has also shown§ that the amount of heat which reaches us from portions of the disk near the margin is less than from the centre, in the same way as is the case with solar light and apparently according to the same law; so that a region of the disk 22″ distant from the limb emits only half as much heat as is emitted from one of equal area near the centre; and we are thus justified in considering that where we observe differences in the inten-

*Zach's *Monatl. Correspondenz*, Oct. 1803.

†*Monum. Sæc. d. K. Bayerichen Akad.* "*Untersuchungen über die Lichtstärke der Planeten*," etc.

‡Mem. Amer. Phil. Society. IV., 173.

§*Comptes Rendus.* 1852.

sity of solar light, there also are corresponding differences of solar heat. The total brilliancy and warming power of the sun must vary somewhat with the area upon his surface which is occupied by spots, and the labors of Schwabe, in Germany, of Wolf, in Switzerland, and of Carrington and the Kew observers in England, have afforded much valuable information on this subject during recent years. Messrs. De La Rue, Stewart and Lœwy, under whose directions very thorough measurements have been made of the area of the spots as delineated on Carrington's charts, have published* a table showing the proportionate area upon the face of the sun which was occupied by spots on each day comprised in his series of observations. The largest amount of spotted surface, which I find in this seven years' series was on September 1, 1859,

Frequency of Spots on the Sun.

Year.	Number of Days.	Number of Groups.	Days without spots.	Year.	Number of Days.	Number of Groups.	Days without Spots.
1826	277	118	22	1848	278	330	0
1827	273	161	2	1849	285	238	0
1828	282	225	0	1850	308	186	2
1829	244	199	0	1851	308	151	0
1830	217	190	1	1852	337	125	2
1831	239	149	3	1853	299	91	4
1832	270	84	49	1854	334	67	65
1833	267	33	139	1855	313	79	146
1834	273	51	120	1856	321	34	193
1835	244	173	18	1857	324	98	52
1836	200	272	0	1858	335	202	0
1837	168	333	0	1859	343	205	0
1838	202	282	0	1860	332	210	0
1839	205	162	0	1861	322	204	0
1840	263	152	3	1862	317	160	3
1841	283	102	15	1863	330	124	2
1842	307	68	64	1864	325	130	4
1843	312	34	149	1865	307	93	26
1844	321	52	111	1866	349	45	76
1845	332	114	29	1867	312	25	195
1846	314	157	1	1868	301	23	101
1847	276	257	0				

on which day $\frac{41}{100}$ of one per cent. of the disk consisted of spots; about four-fifths of this amount being penumbra, and one-fifth of it nucleus. On the other days the degree of spottiness varied between this maximum amount and an entire absence of all spots. This variation is itself by no means without regularity, but is governed to a considerable degree by a curious law. In 1843, after

*Researches in Solar Physics. Second Series.

Schwabe had carried on his spot observations for sixteen years, he discovered that their frequency was periodic, so that, while in 1828 and 1829, and also in 1836 and 1839, there was no day upon which spots were not visible, there were on the other hand more than one-third of all the days in 1833 and 1843 when no spot whatever could be detected. Hence the existence of a periodicity in their recurrence was manifest, and he estimated the length of the period at about ten years.* Subsequent observations have fully corroborated this important discovery, and the accompanying tabular view presents a summary of the results obtained by Schwabe since the beginning of his series of observations.

The great extent of the periodic variation will readily be recognized upon a glance at the third and fourth columns of this table, and it should be added that the abundance of the faculæ appears to follow the same law as that of the spots, being greatest when the latter are most frequent, and disappearing to a great extent during the spotless seasons.

(To be continued.)

MINERALOGICAL NOTES FOR 1870.

By Wm. H. Wahl.

New Minerals.—From various available sources of reference it appears that during the year 1870, about eleven new species have been added to the catalogue of minerals, with the usual abundance of new varieties. The following historical list will suffice to give a general idea of the character of the new additions.

Glaukopyrite.—Announced by Prof. F. Sandberger, occurs at Guadalcanal in Spain, associated with Calcite, Tetrahedrite, Pyrargyrite and sulphide of antimony. It is described as occurring in rounded aggregations, which when magnified are found to be composed of a series of thin layers. The structure is mainly finely granular. Crystals are not sufficiently developed to be definitely determinable, but Sandberger suspects them to belong to the orthorhombic system. He also believes that he has detected twins and triplets, bearing a general resemblance to those of Cerussite. The mineral is described as follows: Lustre, metallic; color, light lead-gray, approaching tin-white; streak, grayish black; hard, 4; specific gravity, 7·181.

**Astron. Nachrichten.* XXI., 234.

The chemical examination gave the following as its constitution:

Sulphur	2·36	Iron	21·38
Arsenic	66·90	Cobalt	4·67
Antimony	3.59	Copper	1·14

The species approaches nearly to the Geyerite of Breithaupt, but differs in color, specific gravity, and in containing copper. It would fall in Dana's pyrites division as a member of his Marcasite group.

Rabdionite is the name assigned by v. Kobell to a new metallic mineral, belonging to the class of hydrous oxides of which Wad and Asbolan are representatives It differs, however, from the latter, which it approaches very nearly in chemical composition, in several important particulars. It is crystallized, occurring in short prisms; it has more water, and is more readily fusible. Its characteristics are described as follows: Color, black; mat; streak, dark brown; very soft, so that taken between the fingers it readily rubs away, leaving a stain behind.

Namaqualite.—Church describes under this name a new copper ore, from Namaqualand, South Africa. It is described as occurring in thin, fibrous masses, alternating with silicate of copper. Color, light blue; lustre, silky; hardness, 2·5; specific gravity, 2·49. It consists mainly of oxide of copper, alumina and water, with small quantities of magnesia, lime and silicic acid.

Phosphorchromite—Occurs at Beresowsk upon Listwänite, associated with Crocoisite and Pyromorphite. It occurs in spherical aggregates, the surfaces of which display minute crystal facets. Internally, the spheres are partly crystalline and partly dense in texture. The mineral is described by R. Hermann as follows: Color, dark green; streak, lighter; hard., 3; sp. gr., 5·80. The analysis gave:

Plumbic oxide	68·33	Chromic acid	10·13
Cupric "	7·36	Phosphoric acid	9·94
Ferrous "	2·80	Water	1·16

Epiboulangerite.—Websky describes a new ore from Altenberg, occurring with Mispickel, Blende, Galena and Pyrites. It occurs in needles of a dark gray color. Though not suggested by the author, it may prove to be analogous in crystallization to antimony glance, as it is, in chemical constitution. It differs from Boulangerite, of

which it is doubtless a changed product, in containing from 21 to 22 per cent. of sulphur.

Amblystegite.—G. vom Rath gives this name to a new member of the Pyroxene group containing alumina. The mineral occurs in the curious Sanidin bombs from the remarkable volcanic region of Lake Laach, in the Eifel. The new mineral was long held by Wolf, the well known historian of Laach minerals, to be an Olivin, to which its crystallization (orthorhombic) bears a close resemblance. The pyramid is, however, much more obtuse, (measured over the macrodiagonal edge, it gives 125° 58½″, and the dimensions of the axes are determined to be $a : b : c = 0{\cdot}97 : 1 : 0{\cdot}570$.) Its cleavage is described to be inappreciable: hard., nearly 7; sp. gr., 3·4; color, brown to reddish-brown; lustre, adamantine. Chemical composition:

Silicic acid	49·8	Alumina	5·05
Ferrous oxide	25·6	Lime	0·15
Magnesia	17·7		

Uranotil.—Boricky gives this name to a mineral occurring in a drusy quarz which coats the surface of feldspar at Walsendorff, in Bavaria. The character of the occurrence is in fine needles, which v. Zepharovich determines to belong to the orthorhombic system. The needles display frequently a radiated structure. Color, lemon-yellow; sp. grav., 3·95; streak, lighter. The mineral blackens before blowpipe. Constitution:

Uranium sesqui oxide	66·752	Silicic acid	13·781
Alumina (Ferric oxide)	0·511	Pposphoric acid	0·448
Lime	5·273	Water	12 616

Both in crystallographic and chemical character it approaches the Uranophan of Websky.

Jacobsite.—A new spinell is described by Damour under this name. It crystallizes in ocahedra, which are frequently much distorted. Color, black; lustrous, opaque; hard., cuts glass; sp. gr., 4·75. It contained, according to analysis, 4·21 per cent. of peroxide and 20·57 per cent. of the protoxide of manganese. The peroxide constituent is chiefly iron. Small quantities of magnesia and zinc oxide are also present. It may therefore be termed a manganese spinell. It occurs at Jacobsberg, in Sweden, in crystalline limestone, associated with silvery mica and particles of native copper.

Gümbelite.—Named by v. Kobell in honor of the geologist, Gümbel, is described as a greenish-white mineral, of a pearly or silky lustre; translucent, soft and flexible, and like asbestos to the touch. Occurs in Oberfranken. It consists essentially of a hydrous silicate of alumina, containing likewise a small proportion of potash and ferric oxide.

Milarite.—A new Swiss zeolite occurring in a granite rock in company with smoky Quartz, Orthoclase, Apatite, Chabacite, &c., is described by Prof. Kengott. Its crystallization is hexagonal, the forms being small but sharp, and combinations of prism and pyramid of both orders, (the polar interfacial angle of pyramid = 144° 46′ 5″.) The analysis shows it to be a hydrous soda, lime and alumina silicate. Its name is derived from its occurrence in the Val Milar. Color, white to green; hard., 55·6.

It will be noticed that Gmelinite, which approaches very nearly in chemical character, presents a further resemblance to the mineral just described, in its crystallization, which is hexagonal (holohedric.) The angle of its pyramid is 142° 25′, a variation of but 2° from the measurement which Kengott announces for Milarite.

Hessenberg describes likewise another zeolite from the volcanic region of Santorin. The crystals are short orthorhombic prisms. Before blowpipe it swells considerably and fuses readily to white glass. Prof. H. describes it as very closely resembling Epistilbite. From the similarity, almost identity, of the angle of the prism (the difference scarcely amounts to 1°), it would seem highly probable that the two were the same.

Sandberger describes several new hydrated phosphates, one of which, a phosphate of lime, is analogous to the hydrated phosphate of copper, known as Libethenite. The crystals are colorless, belong to the monoclinic system, and possess a prismatic habitus. No name has as yet been proposed for it.

Simonyite is a new sulphate, found in the salt works at Hallstadt, and described by Tschermak. It occurs associated with Rock-salt and Anhydrite, chiefly in thin layers of a blueish-green color, presenting here and there a crystalline form, which is announced to be monoclinic. It is a hydrous magnesia-soda sulphate.

Of the numerous varieties which have been announced, the following seem to be the most interesting:

Lithiophorite.—An ore of manganese, containing lithia. It is amorphous, occurring in thin layers; also, pseudomorphic after

Calcite. It colors the flame intensely red. It is found in the granite of Schneeberg, Schwartzenberg and Johanngeorgenstadt—generally coating Quarz. The granite is much decomposed, and with the spectroscope gives distinct indications of the presence of lithia.

A new Olivine.—Roepper gives the following as the composition of a mineral occurring in crystals of an inch or two in length, at Sterling, N. J. It is found associated with Willemite, Franklinite, Jeffersonite and Spinell.

Silicic acid	29·90	Oxide of Zinc	10·66
Iron protoxide	35·60	Magnesia	5·81
Oxide of Manganese	16·90	Insoluble	1·03

The crystalls were weathered externally, but within were bright. Color, dark green to black; hard., 5·5—6. A zinc deposit was obtained with the blowpipe. The crystallization and analysis prove it to be an Olivine. The proportion of zinc and manganese in its composition make it a most interesting variety.

The same author describes a *manganese Dolomite*, from or near the same locality. It is a rosy-red mineral, occurring in a vein of apple-green Willemite. It possesses distinct rhombohedral cleavage. Hardness = 4; sp. gr., 3·05. An analysis gave as much as 43·5 per cent. of carbonate of manganese, 50 per cent. of carbonate of lime; the remainder consisting of carbonate of iron and magnesia. Accordingly Roepper characterizes it either as a Dolomite in which the magnesia has been replaced almost entirely by manganese, or as a Daillogite, in which a large proportion of the manganese has been replaced by lime.

Hallite, a micaceous (or chloritic ?) mineral from Chester county, Pennsylvania, has been announced by Leeds. It is flexible, of a brownish color, and occurs in plates of various sizes. It is believed to possess distinguishing optical properties, though no investigation of the subject has yet appeared.

Metacinnabarite.—G. E. Moore has announced the occurrence, in Lake county, California, of an amorphous sulphide of mercury in a silicious gangue, in company with Cinnabar. It frequently covers crystals of Pyrites, and is filled with small cavities in which are found crystals of Cinnabar. The color is greyish-black; streak on porcellane, pure black; hard. = 3; sp. gr., 7·7. It gives all the reactions of Cinnabar, with which it is identical in composition. The author very properly identifies it as the variety of sulphide obtained in the laboratory as an amorphous black powder, upon precipitating a soluble mercuric salt. He proposes the name given above to designate the variety.

Franklin Institute.

Proceedings of the Stated Meeting, March 15th, 1871.

HALL OF THE INSTITUTE, March 15, 1871.

The meeting was called to order at the usual hour, with the President, Mr. Coleman Sellers, in the chair. The minutes of the last meeting were read and approved. The Actuary submitted the minutes of the Board of Managers, and reported that at the stated meeting held March 8th inst., donations to the library were received from the Society of Arts, the Institute of Civil Engineers, Lt. Gen. Edward Sabine, London, England; Hon. U. S. Secretary of State; Hon. W. D. Kelley, Washington, D. C., and Messrs. Hillibrand and Wolf, Philadelphia.

The committee appointed to report on the estimation of the horse-power of engines and boilers reported progress.

The Secretary then read his monthly report on Novelties in Science and the Mechanic Arts. Upon which the meeting adjourned.

W. H. WAHL, *Secretary.*

Proceedings of the Stated Meeting, April 19th, 1871.

The meeting was called to order by the President, Mr. Coleman Sellers. The minutes of the last meeting were read and approved. The Actuary submitted the minutes of the Board of Managers, and reported that at their stated meeting held April 12th, donations to the library were received from the R. A. Society; the Statistical Society and the Society of Arts, London; from L. A. H. Latour, Montreal, Canada; the Mercantile Library Association, San Francisco, California; the Board of Water Commissioners, Detroit; Michigan; Thomas U. Walter, Germantown, Philadelphia; Mrs. Wm. Swain, West Philadelphia; The American Pharmaceutical Association and George M. Conarroe, Esq., Philadelphia.

The President thereupon announced the paper of the evening to be on the Use of Pulverized Fuel, by Lieut. C. E. Dutton, U. S. Arsenal at Frankfort. The paper was an exhaustive treatment of